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Home, Yard, & Garden

PEST GUIDE



**IN CASE OF PESTICIDE POISONING EMERGENCY, CONTACT LOCAL EMERGENCY
MEDICAL PERSONNEL BY DIALING 911 OR HOSPITAL EMERGENCY CENTER.**

The information in this handbook was prepared by specialists employed by University of Illinois Extension, College of Agricultural, Consumer and Environmental Sciences, and the Illinois Natural History Survey. The suggestions herein are intended to provide current guidelines for pest management in Illinois.

Because laws and regulations change, University of Illinois Extension assumes no liability for the suggestions for using pesticides that are included in this handbook. These suggestions are incomplete; therefore, they should be used only as guidelines. Complete instructions for the use of a specific pesticide are on the pesticide label. Read and follow the label directions and precautions before applying any pesticides. The pesticide user is responsible for applying pesticides according to label directions, as well as for problems that may arise through misapplication or misuse of the pesticide.

Not all pesticides registered for landscape and turf pests are included in this handbook. Effective pesticides that do not present an undue hazard to the user and the environment are suggested whenever possible. Trade names have been used for clarity, but their use does not constitute and endorsement by the University of Illinois, nor does it imply discrimination against other products.

Label changes, product cancellations, and changes in suggestions may have occurred since the publication of this handbook. Check with your nearest Extension office if you are in doubt about a pesticide that you plan to use. Announcement of new registrations, label changes, and changes in suggestions will be made through newsletters and appropriate media sources.

Urbana, Illinois

March 2001

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Editor: Mary H. Overmier, ITCS

Photographer: David A. Riecks, ITCS

Designer: Paul Edwards, Midnight Graphics Online
creative@midnightgraphicsonline.com

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Home, Yard, & Garden PEST GUIDE

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CONTENTS

Chapter 1: Managing Insect Pests in the Home, Yard, and Garden

Insect/Mite Feeding	1
Insect Leftovers	1
Asian Lady Beetle	2
Asian Longhorned Beetle	2
Gypsy Moth	3
Insecticidal Nematodes	4
White Grubs in Turf	5
Termite Control.....	5
Sources of Information on Insects.....	7
Table 1. Management Suggestions for Insects in Vegetables	7
Table 1A. Days Between Insecticide Application and Harvest	10
Table 2. Management Suggestions for Insects in Flowers.....	10
Table 3. Management Suggestions for Insects in Trees and Shrubs	12
Table 4. Management Suggestions for Insects in Lawns.....	16
Table 5. Management Suggestions for Household Insects	17
Table 6. Names of Insecticides	24
Table 7. Conversion Table for Small Quantities of Insecticide	31

Chapter 2: Controlling Weeds in Home Lawns

Weed Life Cycles.....	33
Lawn Weed Control	34
Weed-Control Groups.....	37
Table 1. Recommended Turfgrass Planting Combinations for Specific Midwest Sites and Applications	35
Table 2. Suggested Mowing Heights for Commonly Used Turfgrass Species	35
Table 3: Postemergence Herbicide Control of Broadleaved Weeds in Turf.....	39
Table 4: Timing Applications of Broadleaf Postemergence Herbicides	40

Chapter 3: Controlling Weeds in the Home Garden

Prevention	43
Cultivation and Mechanical Removal	43
Mulching	44
Ground Covers	45
Herbicides	45
Pesticide Safety	48
Classification of Herbicides.....	50
Table 1. Preemergence Herbicides Recommended for Application by Home Gardeners.....	47
Table 2. Postemergence Herbicides Recommended for Application by Home Gardeners.....	48
Table 3. Efficacy Ratings of Herbicides Recommended for Application by Home Gardeners.....	49



Chapter 4: Managing Plant Diseases in the Home Landscape

Diagnosis	53
Before You Spray	54
How to Use This Chapter	54
Table 1. Report on Plant Disease Series	56
Table 2. Product Labeled for Turfgrass Diseases	60
Table 3. Disease Symptoms of Flowers and Nonwoody Ornamentals	63
Table 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals	65
Table 5. Disease Symptoms of Woody Ornamentals.....	82
Table 6. Products Labeled for Specific Woody Ornamentals	84
Table 7. Pesticides Listed in Tables 2, 4, and 6.....	103

Chapter 5: Managing Diseases in the Home Vegetable Garden

Disease Control Before Planting	105
Cultural Practices	107
Disease Control During the Growing Season.....	107
Principal Diseases of Vegetables and Recommended Control Measures	108
Key to Seed Sources	122
Table 1. Disease-Resistant/Tolerant Bean Varieties	110
Table 2. Disease-Resistant/Tolerant Cabbage Varieties	111
Table 3. Disease-Resistant/Tolerant Muskmelon Varieties	112
Table 4. Disease-Resistant/Tolerant Watermelon Varieties	112
Table 5. Disease-Resistant/Tolerant Cucumber Varieties	113
Table 6. Disease-Resistant Pea Varieties	113
Table 7. Disease-Resistant/Tolerant Pepper Varieties	115
Table 8. Disease-Resistant Sweet Corn Varieties	118
Table 9. Disease-Resistant/Tolerant Tomato Varieties	119
Table 10. Fungicides for Use by Vegetable Gardeners	120

Chapter 6: Managing Pests in Home Fruit Plantings

Production Tips	125
Disease-Resistant Apple Trees	125
Insecticides and Fungicides	126
Instructions and Tips for Spraying	129
Preventing Mouse Damage	130
Preventing Rabbit Damage	131
Preventing Bird Damage	131
Additional Information	131
Table 1. Approximate Amount of Spray Required for Fruit Trees of Various Sizes	130
Table 2. Spray Schedule for Apples, Crabapples, Pears, and Quinces	132
Table 3. Spray Schedule for Grapes.....	133
Table 4. Spray Schedule for Blueberries	133
Table 5. Spray Schedule for Peaches, Nectarines, Apricots, Plums, and Cherries	134
Table 6. Spray Schedule for Strawberries	135
Table 7. Spray Schedule for Brambles (Blackberries and Raspberries)	136
Table 8. Relative Effectiveness of Selected Fungicides Against Specific Diseases of Various Fruit Crops	137

Chapter 7: Integrated Pest Management and Pesticide Safety

Integrated Pest Management for Homeowners.....	139
Pesticides in the Environment	143
Labels	149
What Information Is Found on a Pesticide Label.....	149
Human Pesticide Protection	149
Understanding Pesticides	155
Pesticide Characteristics	155
Table 1. <i>Bacillus thuringiensis</i> (Bt) Types and Insect Groups They Are Used On	141
Table 2. Natural Enemies That Can Be Found in Landscapes and Gardens or Purchased	142
Table 3. Plants That Can Be Used in Landscapes and Gardens to Attract Natural Enemies.....	145
Table 4. Pesticide Label Signal Words	151
Table 5. Pesticide Formulations.....	158
Table 6. Tank Sprayers.....	159
Table 7. Granular Applicators.....	162
 Appendix: Plant Clinic Data Form	 165



CHAPTER 1



MANAGING INSECT PESTS IN THE HOME, YARD, AND GARDEN

Insect/Mite Feeding

Insects and mites that attack ornamental plants feed in various ways. The five major feeding behaviors are chewing, sucking, mining, boring, and galling. Chewing insects (beetles, caterpillars, grasshoppers, earwigs, and weevils) physically remove portions of plants, such as leaves, or consume entire plants. Sucking insects/mites (aphids, whiteflies, mealybugs, scales, leafhoppers, and spider mites) possess mouthparts that are inserted into the plant to remove fluids. They generally cause plants to stunt and wilt. In addition, many sucking insects transmit plant viruses. Mining insects (beetles, caterpillars, wasps, and flies) create tunnels on plant leaves or stems as they feed below the leaf surface. Wood-boring insects (beetles, caterpillars, and wasps) feed within the food- and water-conducting portions of plants, causing plant stunting, wilting, and possibly death. Galling insects/mites (aphids, thrips, eriophyid mites, adelgids, and cynipid wasps) exist within the internal portions of plants, creating outgrowths on leaves and branches. Galls, in general, are not harmful to plants.

Pest-management options depend on the feeding behavior of the insect or mite. Chewers, suckers, and miners are generally easier to manage, especially with pest-control materials such as insecticides, because they are exposed. In addition, they are more susceptible to natural enemies (parasitic wasps and predators). In contrast, borers and gallers are protected within the plant, which makes control very difficult.

Insect Leftovers

To properly diagnose an insect problem on ornamental plants, it is best to actually see the organism causing the problem. However, sometimes it is possible to rely on “insect leftovers” as a way to determine the cause of a problem. Insects can leave subtle reminders or remains that indicate their presence. Most insect leftovers are a direct result of insects’ feeding on plants; however, they may leave evidence from the normal process of molting (shedding of old outer skin) as a result of getting larger or changing into another life form. Aphids, for example, leave white cast skins as evidence of molting. These cast skins may be mistaken for whiteflies or dead aphids.

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.



Colorado potato beetle

Many insects with piercing-sucking mouthparts (aphids, whiteflies, soft scales, and mealybugs) produce a clear, sticky liquid called honeydew as evidence of their presence. The reason these types of insects produce honeydew (sometimes in large quantities) is that they require protein (in the form of amino acids) for development. However, to obtain their normal requirement, they must consume large amounts of plant sap. Plant sap contains an assortment of other materials in larger quantities than amino acids. The excess is then excreted as honeydew.

Honeydew is a problem for several reasons. First, it can attract stinging insects (for example, wasps, hornets, and yellowjackets), which may lead to an increased incidence of people getting stung. Second, it attracts carpenter and other ants, which protect piercing-sucking insects such as aphids from natural enemies (for example, parasitic wasps and predators). Third, it is an excellent growing medium for black sooty mold fungi, which may reduce the plants' ability to manufacture food.

Chewing insects, especially caterpillars, may leave evidence of their presence in the form of fecal material or frass deposits. This is the excess, similar to piercing-sucking insects, that is excreted, as caterpillars tend to consume more than they can use. For example, a gypsy moth can consume 1 square foot of leaf material per day, which results in the production of tremendous amounts of frass.

Insects such as lace bugs and thrips tend to leave black, hardened fecal deposits on the undersides of leaves. This type of insect leftover is characteristic of these insects and helps in identification.

Many wood-boring insects leave very noticeable leftovers when they infest a plant. This occurs when the larvae tunnel within the plant or when adults use their chewing mouthparts to create emergence openings. An excellent way to determine if wood-boring insects are the problem is to look for the presence of sawdust-like deposits (also known as wood shavings) at the base of plants or below entry sites.

These are just a sample of insect leftovers from some general insect groups. So, although it is best to have the actual insect causing the problem to make an accurate diagnosis, using insect leftovers is another way to possibly identify the problem.

Multicolored Asian Lady Beetle

The multicolored Asian lady beetle, *Harmonia axyridis*, is a native of Asia and was introduced in the southeastern United States to deal with aphids on pecan trees. However, it spread rapidly to other portions of the United States. It is a tree-dwelling lady beetle and a very good predator of aphids and scales. The pair of white, oval markings directly behind the head, which forms a black M-shaped pattern, can distinguish the multicolored Asian lady beetle from other species of lady beetles. Adults are $\frac{1}{4}$ inch long, $\frac{3}{16}$ inch wide, and yellow to orange in color. In addition, the body is usually covered with 19 black spots. Adults can live for 2 to 3 years. There are multiple generations per year. The multicolored Asian lady beetle is a nuisance pest because the adults tend to congregate and overwinter inside buildings in large numbers. Although it may bite, it does not injure humans, nor can it breed or reproduce indoors. It is attracted to lights and light-colored buildings, especially to the warm, south side.

Beetles can be prevented from entering homes by caulking or sealing cracks and crevices. Beetles already in homes can be physically removed by vacuuming or sweeping. Commercially available indoor light traps can be effective. If crushed, the beetles leave a stain. The dust produced from an accumulation of dead multicolored Asian lady beetles behind wall voids may trigger allergies or asthma in people. Insecticides are not recommended for use indoors.



Multicolored Asian lady beetle

Asian Longhorned Beetle

The Asian longhorned beetle, *Anoplophora glabripennis*, is native to China, where it feeds on many different types of hardwood trees. The beetle feeds on maples (*Acer* spp.), including boxelder, sugar, silver, red, and Norway maples. Additional hosts

are horsechestnut, black locust, and ash trees, as well as elms, birches, willows, and poplars. The beetle was first reported in New York in 1996. It was then found in Chicago in 1998. It arrived in wooden crating material containing goods from China and other areas of east Asia.

The adult Asian longhorned beetle is about $\frac{3}{4}$ inch to $1\frac{1}{4}$ inches long. Its shiny black body is covered with about 40 white spots, predominantly on its abdomen. Its long antennae are one-and-a-half to two-and-a-half times its body length, with black and white rings on each segment. The feet have a blue tinge.

The female chews holes in the bark of trees to lay eggs. Each female is capable of laying from 30 to 70 eggs. After she has laid the eggs, she covers them with bark, and plant sap may flow from these wounds. The eggs hatch into white, wormlike larvae that bore into tree trunks and branches. Larval tunneling can girdle tree stems and branches. Later, beetles chew their way out, leaving exit holes $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter. The egg-laying and emergence holes generally occur on the upper side of branches. Adults are active from May to October, but they can be found earlier in spring or later in fall if temperatures are warm. During the rest of the year, they are located deep within infested trees. A generation usually takes one year, and they have no natural enemies in the United States.

If you find an Asian longhorned beetle, contact your local Extension office or the Illinois Department of Agriculture. For additional information on the Asian longhorned beetle, consult the following Web site:

<http://www.na.fs.fed.us/spfo/alb/>



Asian longhorned beetle

Gypsy Moth

The gypsy moth, *Lymantria dispar*, is a leaf-feeding insect that is a serious threat to many forest and ornamental trees. It is native to Europe, southern Asia, and Africa. Gypsy moth has spread throughout the northeastern and midwestern portions of the United States, infesting and defoliating millions of acres.

Gypsy moths spread from infested to uninfested areas by being transported by people. The egg masses and other life stages can be found on cars, recreational vehicles, firewood, nursery stock, children's outdoor toys, and outdoor household furniture. It is important that these items be thoroughly inspected before returning home from a gypsy moth-infested area.

The severity of a gypsy moth invasion cannot be understated, as continued defoliation of homes, landscapes, urban parks, and recreational areas may have a significant economic impact on the state by reducing home values and tourism. Gypsy moth is a regulated pest, which means that federal and state agencies are responsible for monitoring and implementing control efforts in areas infested with gypsy moth.

Gypsy moth undergoes four developmental life stages; these are the egg, larva (caterpillar), pupa, and adult. Gypsy moth females lay between 500 and 1,000 eggs in sheltered areas, such as underneath the bark of trees. The eggs are covered with a dense mass of tan- or buff-colored hairs. The eggs are the overwintering stage of the insect. Eggs are attached to trees, houses, or any outdoor objects. The eggs hatch in spring into caterpillars.

Gypsy moth caterpillars possess five pairs of blue dots followed by six pairs of red dots lining the back. In addition, they are covered with hairs. Young caterpillars spread to new locations by crawling to the tops of trees, where they spin silken thread and are caught on wind currents. The caterpillar stage eats the leaves of trees. They can consume tremendous amounts of leaf material. As a result, they produce a large amount of frass. When populations reach outbreak proportions, the caterpillars can completely defoliate host trees over a wide geographic area. Repeated defoliation over several years can have devastating effects, often leading to tree stress and death.



Gypsy moth larva

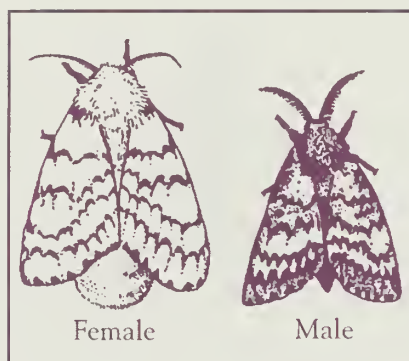
Gypsy moths have a wide host range, which includes oaks, crabapple, linden, poplar, beech, willow, birch, sweetgum, and hawthorn. Trees less susceptible to attack are ash, sycamore, honeylocust, dogwood, junipers, yew, lilac, arborvitae, and tulip tree.

Conifers, such as pine and spruce, are more susceptible to death than deciduous trees because they don't produce another flush of growth once defoliated. As a result, conifers can die after one severe defoliation.

In early summer, gypsy moth enters a pupal stage. They are primarily located in sheltered areas such as tree-bark crevices or leaf litter. Adult gypsy moths are present from July into August. Females have white- to cream-colored wings, a tan body, and a 2-inch wingspan. Female gypsy moths cannot fly. Males, which are smaller than females, with a 1½-inch wingspan, are dark brown and have feathery antennae. Both the adult female and male can be identified by the inverted V-shape that points to a dot on the wings. Gypsy moth has only one generation per year.

The only way to manage gypsy moths is to arrest their migration. The main strategy to manage gypsy moth movement is called slow-the-spread (STS), which is designed to delay the amount of territory invaded, through trapping and applying insecticides. To prevent further spread, before moving out of an infested area, be sure to visually inspect all vehicles and outdoor items to prevent transporting gypsy moth to uninfested areas.

To determine the spread of gypsy moth, federal and state agencies conduct comprehensive trapping programs. This monitoring provides a means of determining the potential infestation of an area and if a quarantine should be implemented. When large numbers of gypsy moths are detected in traps, then an area may be designated as quarantined.



Gypsy moth adults

Insecticidal Nematodes

Insecticidal nematodes, also called entomopathogenic nematodes, only attack insects and their relatives. The infective juvenile stage of the nematode usually enters a natural opening of the insect, such as the mouth, anus, or spiracle. (Spiracles are openings used by the insect for breathing.) Once inside the insect, the nematode penetrates the gut lining or air tube, releasing bacteria. These bacteria attack and feed on the blood and other body tissues of the insect, causing death within 2 days.

Insecticidal nematodes are rather fragile animals, being very susceptible to drying and to the ultraviolet rays in sunlight. For this reason, insecticidal nematodes are most effective in the soil and tunnels of boring insects, where they are protected from dry air and sunlight.

Steinernema carpocapsae is sold as Biosafe. It is most effective against very active insects near the soil surface, such as cutworms, armyworms, sod webworms, and other soil-living caterpillars.

Heterorhabditis bacteriophora is commonly called Hb nematode in trade literature and is sold under the trade names Cruiser and Gardens Alive Hb Nematodes. It searches through the soil for hosts, which makes it more effective than *Steinernema carpocapsae* against less active insects such as white grubs, black vine weevil larvae, and fungus gnat larvae.

Application of insecticidal nematodes is normally recommended for late in the day, preferably after 3 p.m., when the sun is low enough to reduce evaporation and intense sunlight. For turf applications, the turf should be wetted both before and immediately after application to reduce the chances of the nematodes' drying out and dying. Similarly, sufficient irrigation, usually at least ½ inch, is needed to move the nematodes into the soil, where they are protected from both drying and ultraviolet light.

Levels of control with insecticidal nematodes can be quite high, but 60 to 70 percent control is more common in turf applications. This level of control is usually

enough to reduce pest numbers below damaging levels. Although insecticidal nematodes are living organisms and reproduce in attacked insects, they should be used as conventional insecticides are used: Apply them when control is needed. Do not expect the nematodes to survive in the soil from year to year in sufficient numbers to provide a high level of control.

Being living organisms, insecticidal nematodes are exempt from many of the US EPA's pesticide regulations. Tests have shown them to be harmless to mammals. This trait allows them to be introduced into the market much more quickly than chemical insecticides. However, they avoid much of the consumer protection provided by pesticide registration. When using a new insecticidal nematode or one under an unfamiliar label, try it out on a small area to be sure that you are satisfied with the results before applying it to a large area.

White Grubs in Turf

The primary white grubs that attack turfgrass in Illinois are the masked chafers, also known as annual white grubs, and Japanese beetle. Both have a 1-year life cycle. Eggs are typically laid in the first half of July and hatch by early August. The C-shaped, white larvae feed on grass roots, causing the turf to turn brown from mid-August through the fall. Because the roots have been eaten off, the turf is easily pulled up, exposing the white grubs lying in the root zone.

Adult masked chafers and Japanese beetles do not lay very many eggs in dry soil or under tree canopies. Thus, white grubs can be prevented by reducing watering in late June, allowing the turf to become dormant and brownish. It will green back up with rains or watering in August. This approach is probably the most effective non-chemical control of these insects.

In areas where rains have been infrequent and unwatered turf is dry and brownish, preventive treatments for white grubs are justified in irrigated turf, particularly where there is a history of grub problems. Halofenozide or imidicloprid should be applied by the end of July. Both of these insecticides are effective but take 3 weeks to kill the grubs.

In areas where unwatered turf is green due to summer rainfall, there are still likely to be spots where grubs are numerous enough to cause turf damage in August through the fall, especially in areas where Japanese beetle occurs. Browning of turf from white grub root feeding is more likely if there is a prolonged dry period in the fall. To keep on top of the situation, scout for grubs in early August, when most of the eggs should be hatched.

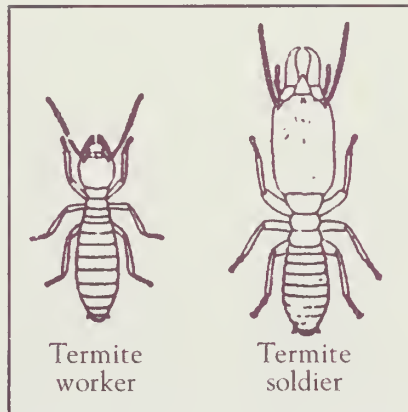
Scout for white grubs by cutting through the turf with a heavy knife. Pull back the turf and count the white grubs in the root zone. Lightly till the soil with the knife to check for grubs a couple of inches deeper. If the soil is not moist in the root zone, this step is particularly important because the grubs move deeper to find moisture. If you find 10 to 12 or more grubs per square foot, treatment is justified. Raccoons, skunks, and birds cause turf damage searching for grubs. If these animals are numerous in the area and you've experienced this type of damage before, realize that these mammals dig when as few as three to five grubs per square foot are present. To treat for grubs found in early August or later, use a quick-acting insecticide such as trichlorfon or diazinon.



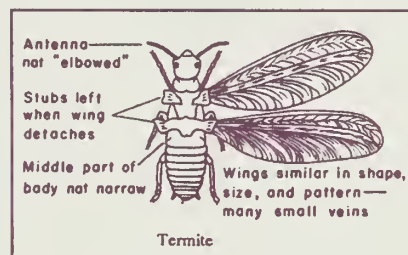
White grub

Termite Control

Termites are capable of causing extensive, expensive damage to houses and other buildings. They remove wood from the inside, leaving no holes or sawdust on the outside, which makes their presence difficult to detect. In addition, Illinois termites are subterranean, that is, they live in underground colonies and can attack a house from a colony located several houses away.



Termites



Winged termite

Nonchemical control options for termites are listed in Table 5. Do-it-yourself chemical-control options for the homeowner are few. Octoborates, sold as Tim-bor and Bora-Care, can be sprayed or painted onto wood to protect it from termites, other wood-boring insects, and wood rot. Jecta is the trade name of a product that can be injected into the wood. Octoborates permanently protect the wood. Because octoborates are very water soluble, treated surfaces exposed to rain should be protected with a coat of paint or varnish.

Permethrin is available to the homeowner for spot-treatment of termite infestations. Sulfluramid, sold as Terminate, is a preventive baiting system available to homeowners. Homeowners can treat an infestation of termites themselves in an old stump, fence, landscape timbers, mailbox post, small shed, or other small structure. In cases where termites are attacking a house or other valuable building, we strongly recommend that a professional pest-control operator be hired to do the job. Although the cost of a professional treatment may appear expensive to some homeowners, proper termite control involves specialized knowledge, considerable labor cost, and (in the case of barrier treatments) specialized equipment.

There are two major options for termite control, barrier treatments and baits. Conventional (barrier) treatments involve treating the soil from the top of the foundation footer to near the soil surface with an insecticide. To provide uniform coverage underground, the insecticide is usually injected every foot along the outside and inside of the foundation. Most systems effectively keep out termites for 5 years or longer. Barrier treatments are meant to protect the structure from termite attack. They do not directly eliminate the colony, although the loss of termite workers coming to a treated building could affect the colony. Insecticides used include

- bifenthrin (Talstar)
- cypermethrin (Demon)
- fenvalerate (Tribute)
- fipronil (Termidor)
- imidacloprid (Premise)
- permethrin (Dragnet, Permethrin Pro, Prelude)

Baits rely on the termite workers' encountering the bait placed in the ground around the building or across a tunnel indoors. The bait, either a slow-acting insecticide or an insect-hormone mimic (insect-growth regulator), is taken back to the colony by the workers where it severely weakens or kills the colony. Baits used include

- diflubenzuron (Labyrinth bait used in the Exterra system)
- hexaflumeron (Recruit bait used in the Sentricon system)
- sulfluramid (FirstLine system, Terminate system)

Both the Sentricon and Exterra bait systems are used as stand-alone systems for existing termite infestations and for termite prevention. FirstLine and Terminate are used alone for termite prevention but should be used in conjunction with spot barrier treatments for existing termite infestations. In cases of known termite infestations, pest-control operators may opt to combine a barrier treatment with either Exterra or Sentricon bait systems, depending on the situation. Again, proper termite control in a house or other valuable building is best conducted by a professional pest-control operator.

Authors

P. Nixon and R. Cloyd

Department of Natural Resources and Environmental Sciences

Sources of Information on Insects

Fact sheets describing the life history, habits, and damage of specific insects and nonchemical methods of management can be obtained from your local Extension office. These fact sheets are indicated by the NHE number in the tables of this chapter.

TABLE 1. Management Suggestions for Insects in Vegetables

Insect	Crop	Strategies	Insecticide
Aphids (NHE-47) Mites (NHE-58) Thrips	most garden crops	Nonchemical. Use forceful water sprays to knock pests off plants. Encourage natural enemies. Chemical. Apply on foliage to control the insects. Aphids and leafhoppers transmit plant diseases; early control is important. Mites web on the underside of leaves; apply insecticide to underside of leaves early, before extensive webbing occurs.	acephate insecticidal soap malathion
Blister beetles (NHE-72) Cutworms (NHE-77) Flea beetles (NHE-36) Grasshoppers (NHE-74) Leafhoppers (NHE-22) Picnic beetles (NHE-40)	most garden crops	Nonchemical. For cutworms, attach collars of paper, aluminum foil, or metal at planting for small numbers of plants. For picnic beetles, pick and destroy overripe or damaged vegetables. Chemical. Apply to base of plants at first sign of cutting by cutworms. Control grasshoppers in garden borders when hoppers are small.	carbaryl permethrin rotenone
All cabbage worms (NHE-45)	cabbage and related crops, salad crops, leafy vegetables	Chemical. Presence of white butterflies signals start of infestation. Control worms when small. It is almost impossible to raise cole crops in Illinois without controlling these pests.	<i>Bacillus thuringiensis kurstaki</i> ^a permethrin
Hornworms (NHE-130) Fruitworms	tomatoes	Nonchemical. Handpicking usually provides satisfactory control of hornworms. Without treatment, fruitworms usually damage less than 5% of the crop, so treatment may not be justified. Chemical. For fruitworms, apply to late-maturing tomatoes 3 or 4 times at 4- to 10-day intervals from small-fruit stage.	<i>Bacillus thuringiensis kurstaki</i> ^a carbaryl permethrin

^aNo time limitations.

TABLE 1. Management Suggestions for Insects in Vegetables (cont.)

Insect	Crop	Strategies	Insecticide
Earworms (NHE-33)	sweet corn	<p>Nonchemical. If corn is harvested by the end of July in the northern half of Illinois, damage is usually avoided.</p> <p>Chemical. Apply at fresh-silk stage to early and late corn every 2 days, 4 or 5 times (carbaryl); or every 5 days, 2 or 3 times (permethrin).</p>	carbaryl cyfluthrin permethrin
Colorado potato beetles	eggplant, potatoes, tomatoes	<p>Nonchemical. Insects are usually present only in late May and June. Handpick larvae and adults off plants.</p>	<i>Bacillus thuringiensis tenebrionis</i> ^a carbaryl cyfluthrin permethrin rotenone
Potato leafhoppers (NHE-22)	potatoes, beans	<p>Chemical. Apply 3 or 4 times at weekly intervals starting in late May or early June. Late potatoes and beans require additional treatments. These pests are the most serious for potatoes in Illinois.</p>	permethrin
Bean leaf beetles (NHE-67)	beans	<p>Nonchemical. Plant late enough so that farmers' soybeans emerge before garden beans, making overwintering beetles less of a problem.</p> <p>Chemical. Leaves are riddled in early plantings. Apply once or twice as needed. Harvest is not affected if less than 20% of foliage is eaten. They also feed on pods.</p>	carbaryl rotenone
Mexican bean beetles	beans	<p>Chemical. Except for southern Illinois, a pest only of late beans. Harvest is not affected if less than 20% of foliage is eaten. Apply insecticide to underside of leaves.</p>	carbaryl rotenone
Cucumber beetles (NHE-46)	vine crops	<p>Nonchemical. In the spring, cover plants with polyester row covers until blooming starts.</p> <p>Chemical. Apply as soon as beetles appear in spring. When blossoming begins, apply insecticide late in the day so as not to interfere with pollination by bees.</p>	carbaryl rotenone

^aNo time limitations.

TABLE 1. Management Suggestions for Insects in Vegetables (cont.)

Insect	Crop	Strategies	Insecticide
Corn rootworm beetles	sweet corn	Chemical. Apply to green silks every 2 or 3 days while beetles are present and clipping silks. Cease treatments when silks turn brown.	carbaryl cyfluthrin
Squash bug	squash	Nonchemical. Handpick masses of reddish brown eggs on leaf undersides. Keep garden free of debris and lay down boards. During the day, remove boards and remove hiding bugs. Chemical. Treat bugs with sabadilla dust.	permethrin sabadilla
Squash vine borers (NHE-8)	squash	Nonchemical. In the spring, cover plants with polyester row covers until blooming starts. Plant second crop in early July. Chemical. Make weekly applications to crowns and runners when plants begin to vine. Apply late in the day.	carbaryl permethrin rotenone
Slugs	all	Nonchemical. Reduce mulches, compost, and other organic matter. Chemical. Apply as bait to soil.	iron phosphate metaldehyde
Soil insects (including grubs, wireworms, root maggots)	all	Nonchemical. Cover the soil with screening along rows of root maggot-susceptible plants in the springtime. For grubs and wireworms, control grassy weeds and avoid root crops in new garden space that had been turf.	
Whiteflies	tomato, squash, others	Nonchemical. Use forceful water sprays to knock pests off plants. Place yellow sticky traps near infested foliage to trap and eliminate adults. Chemical. Make 2 applications 5 to 7 days apart when large numbers are present.	insecticidal soap

^aNo time limitations.

TABLE 1A. Days Between Insecticide Application and Harvest

	Collards, kale, other leafy crops	Beans	Lettuce	Cabbage, related crops	Sweet corn	Onions	Vine crops ^a	Tomatoes	Pumpkin	Eggplant	Peas	Potatoes
carbaryl	14	0	14	3	0	—	0	0	0	0	3	0
malathion	7	1	14	7	5	3	1	1	3	3	3	0
permethrin	—	—	—	1	1	—	—	—	—	3	—	7
rotenone	—	1	1	1	1	1	1	1	—	1	1	1

— = insecticide not labeled for that crop.

^aTo avoid bee kill, apply insecticides late in the day, after blossoms have closed.

TABLE 2. Management Suggestions for Insects in Flowers

Insect	Strategies	Insecticide
Aphids, mealybugs, spittlebugs, scales (NHE-7, -114)	Nonchemical. Encourage natural enemies. Chemical. Spray foliage thoroughly. Repeat treatments may be needed.	acephate disulfoton imidacloprid insecticidal soap malathion
Blister beetles (NHE-72)	Chemical. Spray foliage. Repeat treatments may be needed.	carbaryl cyfluthrin
Caterpillars, including painted lady, woolly-bears, and other leaf-feeding caterpillars	Nonchemical. Handpick caterpillars off plants. Chemical. Spray foliage. Repeat treatments if needed.	acephate <i>Bacillus thuringiensis</i> <i>kurstaki</i> carbaryl cyfluthrin
Cutworms (NHE-77)	Nonchemical. Small numbers of plants may be protected with collars of paper, aluminum foil, or metal. Chemical. Apply to base of plants. Do not spray on plant foliage.	esfenvalerate permethrin
Earwigs (NHE-142)	Nonchemical. Reduce mulches. Trap earwigs in pieces of garden hose or rolled-up newspaper. Dump captured earwigs into soapy water. Chemical. Spray foliage as needed. Do not spray blooms.	carbaryl
Grasshoppers (NHE-74)	Chemical. Spray foliage, also adjacent grassy or weedy areas.	carbaryl

Note: Use only one insecticide from those listed. Do not use oil-based sprays on plants. Do not use malathion on African violets. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns. Repeated use of carbaryl foliage sprays may cause mite or aphid infestations to increase and to become damaging. Do not use insecticides during full bloom. Do not use dimethoate on chrysanthemums.

TABLE 2. Management Suggestions for Insects in Flowers (cont.)

Insect	Strategies	Insecticide
Iris borer	Nonchemical. Tall bearded iris tolerates borer attack. Other, smaller-corm varieties are less likely to get borers but are devastated if borers attack. Chemical. Apply in April when leaves are 5 to 6 inches tall. Make only one application. Add a small amount of liquid detergent to spray mix to improve coverage on leaves.	dimethoate
Japanese beetles and other leaf-feeding beetles	Chemical. Spray foliage. Repeat treatments if needed.	carbaryl cyfluthrin
Mites	Nonchemical. Use forceful water sprays to knock mites off plants. Chemical. Spray foliage. Repeat in 5 days.	bifenthrin dicofol hexakis insecticidal soap
Plant bugs, leafhoppers	Chemical. Spray foliage. Repeat treatments if needed.	acephate carbaryl cyfluthrin
Slugs (NHE-84)	Nonchemical. Remove old leaves, stalks, poles, boards, and other debris where slugs like to hide and lay eggs. Copper edging repels slugs. Chemical. Apply as a bait to soil.	iron phosphate metaldehyde bait
Stalk borers (NHE-24)	Nonchemical. Remove weeds to eliminate hosts of young borers. Chemical. Spray foliage thoroughly and frequently.	acephate carbaryl
Thrips	Nonchemical. Encourage natural enemies by avoiding unnecessary insecticide use. Chemical. Spray foliage thoroughly.	acephate insecticidal soap
Whiteflies (NHE-136)	Nonchemical. Place yellow sticky traps near infested foliage to trap and eliminate adults. Chemical. Spray foliage thoroughly. Repeat in 5 days.	acephate disulfoton insecticidal soap pyrethrin resmethrin

Note: Use only one insecticide from those listed. Do not use oil-based sprays on plants. Do not use malathion on African violets. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns. Repeated use of carbaryl foliage sprays may cause mite or aphid infestations to increase and to become damaging. Do not use insecticides during full bloom. Do not use dimethoate on chrysanthemums.

TABLE 3. Management Suggestions for Insects in Trees and Shrubs

Insect	Strategies	Insecticide
Aphids (NHE-7)	Nonchemical. Use forceful water sprays to knock aphids off plants. Encourage natural enemies. Chemical. Spray foliage thoroughly, with force, when aphids become numerous. Repeat as needed. Check for presence of lady beetles and other predators before spraying.	acephate imidacloprid insecticidal soap malathion
Bagworms (NHE-6)	Nonchemical. Handpicking of bags in winter and early spring reduces later infestations. Chemical. Spray foliage thoroughly. Apply in late June. Later sprays are less effective.	<i>Bacillus thuringiensis</i> <i>kurstaki</i> cyfluthrin
Borers: Ash (NHE-145), lilac (NHE-145), peach tree	Nonchemical. Keep the tree healthy and vigorous, and avoid wounds or injury to the trunk. Prune out large lilac trunks. Chemical. Spray trunk and limbs in early to mid-June or when bridal wreath spirea ^a is in full to late bloom. Repeat 2 weeks later.	lindane
Asian longhorned beetle	Report sightings to your local Extension office.	
Bronze birch (NHE-143)	Nonchemical. Keep trees watered during the summer. Keep trees healthy and vigorous. Chemical. Apply to trunk and limbs in mid-May or when bridal wreath spirea ^a finishes bloom. Repeat twice at 2-week intervals.	lindane
Flatheaded apple tree, oak	Nonchemical. Keep trees healthy and vigorous and avoid trunk wounds. Chemical. Spray trunk and/or limbs in mid-May or when bridal wreath spirea ^a blooms have mostly turned brown. Repeat 2 weeks later.	lindane
Cankerworms (NHE-95)	Chemical. Spray foliage when feeding or worms are first noticed in spring.	acephate <i>Bacillus thuringiensis</i> <i>kurstaki</i> carbaryl
Eastern tent caterpillars	Nonchemical. Remove nests at night and destroy. Chemical. Spray when nests are first noticed.	same as for cankerworms
Elm leaf beetles (NHE-82)	Chemical. Spray as soon as damage is noticed.	acephate <i>Bacillus thuringiensis</i> <i>tenebrionis</i> carbaryl

Note: Use only one insecticide of those listed. Do not use acephate on flowering crab, sugar maple, red maple, redbud, American elm, Lombardy poplar, or cottonwood. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns or hibiscus. Do not use malathion on canaert red cedar.

^a*Spiraea x vanhouttei*.

^b*Catalpa speciosa*.

^cThe following may be damaged by petroleum oil in some situations: beech, Japanese holly, redbud, spruce, Savin juniper, Douglas fir. The following are usually damaged by petroleum oil: maples, hickories, smoke-tree, black walnut, many azaleas. Do not spray petroleum oil on bald cypress.

^d*Daucus carota*.

^e*Magnolia x soulangiana*.

TABLE 3. Management Suggestions for Insects in Trees and Shrubs (cont.)

Insect	Strategies	Insecticide
European pine shoot moths, Nantucket pine moths (NHE-83)	Chemical. Spray ends of branches thoroughly in late June or when catalpa ^b blooms for European species and in mid-May for Nantucket species.	acephate cyfluthrin dimethoate
Fall webworms	Nonchemical. Clip off and destroy infested branches. Chemical. Spray when first webs appear. Make sure spray penetrates webbing.	acephate <i>Bacillus thuringiensis</i> <i>kurstaki</i> carbaryl
Galls (NHE-80, -81): Oak, hickory, hackberry, maple bladder leaf galls	Leaf galls are not harmful to the tree. Treatments are not warranted.	
Cooley spruce, eastern spruce	Chemical. Apply in late September or October; or in early spring, just after budbreak.	dimethoate
Gouty oak, horned oak	Nonchemical. Prune galls out of young trees. On older trees, pruning is not practical.	
Gypsy moth	Nonchemical. Remove egg masses and put into soapy water. Wrap burlap around trunk; remove trapped caterpillars, pupae, and moths daily. Chemical. Spray <i>B.t.k.</i> when caterpillars are small—usually when oak leaves are about half-expanded. Spray egg masses with soybean spray oil.	<i>Bacillus thuringiensis</i> <i>kurstaki</i> soybean spray oil
Imported willow leaf beetles	Chemical. Spray when larvae and foliage are small.	<i>Bacillus thuringiensis</i> <i>tenebrionis</i> carbaryl
Japanese beetle	Nonchemical. Handpick, particularly when beetles first emerge. Traps can result in more damage in heavily infested areas. Chemical. Spray foliage. Repeat treatments if needed.	acephate carbaryl cyfluthrin esfenvalerate
Lace bugs: Oak, sycamore	Chemical. Spray when nymphs appear. However, lace bugs rarely are numerous enough to warrant treatment.	acephate carbaryl malathion
Leaf miners: Boxwood, hawthorn, oak	Chemical. Leaf miners usually do not harm the tree. Spray foliage thoroughly when miners first appear. Repeat treatment in 10 to 12 days. Do not use acephate on boxwood.	acephate

Note: Use only one insecticide of those listed. Do not use acephate on flowering crab, sugar maple, red maple, redbud, American elm, Lombardy poplar, or cottonwood. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns or hibiscus. Do not use malathion on canaert red cedar.

^a*Spiraea x vanhouttei*.

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^cThe following may be damaged by petroleum oil in some situations: beech, Japanese holly, redbud, spruce, Savin juniper, Douglas fir. The following are usually damaged by petroleum oil: maples, hickories, smoke-tree, black walnut, many azaleas. Do not spray petroleum oil on bald cypress.

^d*Daucus carota*.

^e*Magnolia x soulangiana*.

TABLE 3. Management Suggestions for Insects in Trees and Shrubs (cont.)

Insect	Strategies	Insecticide
Leaf miners: (cont.) Birch, holly	Chemical. Spray foliage. Repeat treatment in 3 weeks.	acephate dimethoate
Mealybugs	Nonchemical. Encourage natural enemies by avoiding unnecessary insecticide use. Chemical. Spray foliage thoroughly and with force. Repeat in 2 weeks.	acephate insecticidal soap malathion petroleum oil as summer-oil spray ^c
Mimosa webworms (NHE-109)	Nonchemical. Physically remove and destroy nests. Chemical. Spray foliage thoroughly when first nests appear (June, July). A repeat treatment for second-generation larval feeding may be needed (August).	acephate <i>Bacillus thuringiensis</i> <i>kurstaki</i> cyfluthrin
Periodical cicadas (NHE-113)	Nonchemical. Protect very young trees (less than 2-inch diameter) with screening around the trunk. Treatment not recommended on older trees because they will grow out of damage.	
Plant bugs	Chemical. Spray when nymphs appear in spring.	acephate carbaryl
Potato leafhopper	Chemical. Spray in early summer when damage is first appearing and leafhoppers are present. Repeat if necessary. Leafhoppers will reduce tree growth but not harm tree health, so control is not usually needed.	acephate cyfluthrin
Sawflies	Nonchemical. Handpicking is effective. Chemical. Spray as soon as worms or damage is evident.	carbaryl
Scales (NHE-100, -114, -144, -146)	Nonchemical. Cottony maple scale is naturally controlled by the twice-stabbed lady beetle. Avoid insecticide use if beetles are present. Chemical. Spray foliage when crawlers are present for (1) <i>pine needle scale</i> in late May when bridal wreath spirea is in late bloom or has finished bloom; (2) <i>oystershell scale</i> in late May when bridal wreath spirea is in late bloom or has finished bloom; (3) <i>euonymous scale</i> in early June when catalpa ^b starts to bloom; (4) <i>cottony maple scale</i> in mid-July when Queen Anne's lace ^d is blooming; (5) <i>spruce bud scale</i> in mid-July when Queen Anne's lace is blooming; (6) <i>oystershell scale</i> again in August when Queen Anne's lace is blooming.	acephate insecticidal soap malathion petroleum oil as summer-oil spray ^c

Note: Use only one insecticide of those listed. Do not use acephate on flowering crab, sugar maple, red maple, redbud, American elm, Lombardy poplar, or cottonwood. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns or hibiscus. Do not use malathion on canaert red cedar.

^a*Spiraea x vanhouttei*.

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^cThe following may be damaged by petroleum oil in some situations: beech, Japanese holly, redbud, spruce, Savin juniper, Douglas fir. The following are usually damaged by petroleum oil: maples, hickories, smoke-tree, black walnut, many azaleas. Do not spray petroleum oil on bald cypress.

^d*Daucus carota*.

^e*Magnolia x soulangiana*.

TABLE 3. Management Suggestions for Insects in Trees and Shrubs (cont.)

Insect	Strategies	Insecticide
Scales (cont.)	Apply when plants are still dormant in late winter to control <i>cottony maple</i> (NHE-144) and <i>tulip tree scales</i> . Do not use on evergreens or hard maples. For <i>tulip tree scale</i> , a malathion spray in late September or in early spring is also effective.	petroleum oil as dormant spray ^c
Spruce spider mites	Nonchemical. Use forceful water sprays to knock mites off plants. Chemical. Spray when mites are numerous, usually spring and early fall. Concentrate spray on underside of foliage. Repeat in 5 days.	bifenthrin dicofol insecticidal soap hexakis petroleum oil as summer-oil spray ^c
Thrips	Chemical. Mainly on privet. Spray foliage thoroughly.	same as for aphids
Two-spotted spider mites	Nonchemical. Use forceful water sprays to knock mites off plants. Chemical. Spray when mites are numerous, usually midsummer. Concentrate spray on underside of the foliage. Repeat in 5 days.	bifenthrin dicofol hexakis insecticidal soap petroleum oil as summer-oil spray ^c
Yellow-necked caterpillars	Nonchemical. Handpicking of colonies is effective. Chemical. Spray foliage when worms are small (July).	acephate <i>Bacillus thuringiensis kurstaki</i> carbaryl
Zimmerman pine moths (NHE-83)	Chemical. Spray trunk and branches in mid-April or as saucer magnolia ^e goes from pink bud to early bloom for young larvae and/or mid-August for adults and young larvae.	dimethoate endosulfan lindane

Note: Use only one insecticide of those listed. Do not use acephate on flowering crab, sugar maple, red maple, redbud, American elm, Lombardy poplar, or cottonwood. Do not use carbaryl on Boston ivy. Do not use diazinon on ferns or hibiscus. Do not use malathion on canaert red cedar.

^a*Spiraea x vanhouttei*.

^b*Catalpa speciosa*.

^cThe following may be damaged by petroleum oil in some situations: beech, Japanese holly, redbud, spruce, Savin juniper, Douglas fir. The following are usually damaged by petroleum oil: maples, hickories, smoke-tree, black walnut, many azaleas. Do not spray petroleum oil on bald cypress.

^d*Daucus carota*.

^e*Magnolia x soulangiana*.

TABLE 4. Management Suggestions for Insects in Lawns

Insect	Strategies	Insecticide ^a
Ants (NHE-111); cicada killer and other soil-nesting wasps (NHE-79, -150)	Chemical. Apply as spray or granules and water in thoroughly. For individual nests, pour in nest and cover with soil. Treat only large, damaging nests. Ants are beneficial in aerating the soil. Both ants and wasps kill insect pests.	cyfluthrin
Aphids (NHE-148)	Chemical. Spray grass thoroughly.	acephate insecticidal soap
Armyworms	Chemical. Apply as sprays or granules. Use 5 to 10 gal of water per 1,000 sq ft.	carbaryl <i>Steinernema carpo-</i> <i>capsae</i>
Bluegrass billbugs	Chemical. Drench at high rate in July if damage is observed.	<i>Heterorhabditis</i> <i>bacteriophora</i> imidacloprid <i>Steinernema carpo-</i> <i>capsae</i> trichlorfon
Chinch bugs	Nonchemical. Avoid thick thatch to prevent bug infestations. Chemical. Spray infested areas where chinch bugs are present.	deltamethrin lindane
Sod webworms (NHE-115)	Chemical. Webworms usually damage lawns in late July and in August.	carbaryl deltamethrin <i>Heterorhabditis</i> <i>bacteriophora</i> <i>Steinernema carpo-</i> <i>capsae</i> trichlorfon
White grubs (NHE-104, -147), including annual white grubs, masked chafers, Japanese beetles, and green June beetles	Nonchemical. Adult beetles are attracted to watered lawns to lay eggs. Allow turf to go dormant and slightly brown from late June to mid-July to reduce egg laying. Plant trees: Adult beetles lay few eggs under tree canopies. Chemical. Apply as spray or granules to small area and then apply 1/2 in. of water before treating another small area. Grub damage usually occurs in late August and in September. Apply imidacloprid or halofenozide only once in mid-July if adult beetle flight was high in areas where grub attack is common. Apply carbaryl only for green June beetle grubs.	carbaryl halofenozide <i>Heterorhabditis</i> <i>bacteriophora</i> imidacloprid trichlorfon

^aUse only one insecticide from those listed.

TABLE 5. Management Suggestions for Household Insects

Insect	Strategies	Insecticide
Ants (NHE-111), including carpenter ants (NHE-10) (<i>nuisance pest</i>)	<p>Nonchemical. Keep foods in tightly sealed containers or in the refrigerator. Most ants prefer sweets and fats. Practice good sanitation. Avoid leaving dirty dishes or food particles where they are accessible to ants. Caulk cracks and crevices in house foundation. Washing ant trails with detergent may confuse and greatly reduce ants. Carpenter ants excavate nests in damp wood indoors near current or old roof leaks and water and drain-pipe leaks. Replace damaged wood-containing nests.</p> <p>Chemical. <i>Outdoors:</i> Spray completely around foundation and the adjacent 1 ft of soil. Place baits along areas where ants travel in nonfood areas. Apply an RTU spray to baseboards, cracks, and door thresholds. Apply boric acid in out-of-reach areas only. Spray carpenter ant nests with RTU spray.</p>	<p><i>Outdoors:</i> cyfluthrin esfenvalerate permethrin <i>Indoors:</i> bifenthrin boric acid cyfluthrin cypermethrin diatomaceous earth d-phenothrin fipronil hydramethylnon baits imiprothrin mint oil permethrin propoxur resmethrin tralomethrin</p>
Ants, pharaoh (<i>nuisance pest</i>)	<p>Nonchemical. Follow suggestions given above for other ants.</p> <p>Chemical. <i>Indoors:</i> Place baits near water sources and other areas where ants are found. Treat for several weeks, replacing bait as it becomes dry. Professional help may be needed.</p>	boric acid baits methoprene baits
Boxelder bugs (NHE-9) (<i>nuisance pest</i>)	<p>Nonchemical. Keep screens and other openings in good repair. Caulk all seams around windows and doors. <i>Indoors:</i> Remove the bugs by vacuuming.</p> <p>Chemical. Spray boxelder bugs on tree trunks, on foundation walls (insecticidal soap), under eaves, and in other areas where they gather. Use carbaryl on foliage and under trees where bugs are feeding.</p>	carbaryl insecticidal soap
Bumblebees	<p>Nonchemical. Avoid areas where bumblebees are prevalent. Mow areas near underground nests in evening when bees are less active. Wear protective clothing.</p> <p>Chemical. Apply dust to dry areas around nest openings. Wear protective clothing.</p>	carbaryl
Carpenter bees	<p>Nonchemical. In the fall, fill the holes, and paint or varnish the entire wood surface.</p> <p>Chemical. Dust entrances to nest with insecticide. Do not plug entrance.</p>	carbaryl dust

Note: Those species indicated as *nuisance pests* are primarily a problem due to their presence and are unlikely to cause harm to people, pets, buildings, or building contents. Thus, an acceptable option is to ignore them and not try to control them. Whenever possible, purchase specially prepared, ready-to-use (RTU) forms of insecticides for indoor use. Use only one insecticide from those listed. When preparing 1 gallon or more of a spray, follow the mixing directions on the pesticide label.

TABLE 5. Management Suggestions for Household Insects (cont.)

Insect	Strategies	Insecticide
Carpet beetles, clothes moths (NHE-87)	<p>Nonchemical. Destroy all badly infested materials. Check for any dead mammal or bird carcasses that may be in wall voids, chimneys, or fireplace areas. Keep accumulation of lint to a minimum, and vacuum thoroughly in areas where hair and other natural fibers gather. Remove all bird, insect, and rodent nests in the fall before cool weather. Place cleaned or washed woolens in insect-free chests that are tightly sealed or in plastic bags. Dry cleaning and laundering kill these pests.</p> <p>Chemical. Spray RTUs in edges of carpeting, baseboards, cracks, and crevices. Place cedar shavings, naphthalene, or paradichlorobenzene in folds of woolens stored in airtight containers.</p>	bifenthrin cedar shavings cyfluthrin cypermethrin d-phenothrin naphthalene paradichlorobenzene permethrin resmethrin tralomethrin
Centipedes, millipedes, sow-bugs (NHE-93) (<i>nuisance pest</i>)	<p>Nonchemical. Correct situations where moisture occurs, such as crawl spaces; poorly drained areas; and piles of trash, mulch, or compost. Remove indoors by vacuuming.</p> <p>Chemical. <i>Outdoors:</i> Apply as a foundation spray. Millipedes are not effectively controlled with insecticides. <i>Indoors:</i> Use RTU spray according to label.</p>	<i>Outdoors:</i> cyfluthrin esfenvalerate permethrin <i>Indoors:</i> bifenthrin diatomaceous earth d-phenothrin
Chiggers (NHE-127)	<p>Nonchemical. Eliminate or mow breeding sites, especially tall grass, weeds, and other thick vegetation where there is an abundance of moisture and shade. Wear protective clothing, such as a long-sleeved shirt and trousers, shoes, and socks. Tuck pant legs into boots or socks. Avoid sitting on the ground in lawn or brushy areas. Take a warm, soapy shower or bath immediately after returning from any infested areas.</p> <p>Chemical. Treat lawns, roadsides, and areas not mowed. For personal protection, a repellent such as DEET prevents attack.</p>	carbaryl DEET RTU
Clover mites (NHE-2) (<i>nuisance pest</i>)	<p>Nonchemical. Eliminate grass and other vegetation in a 1-ft band all the way around the house. Also make sure window and door seams are properly caulked and sealed to prevent entry by the mites. <i>Indoors:</i> Mites can be killed and removed by vacuuming and washing surfaces with soap and water.</p> <p>Chemical. Spray mites with insecticidal soap on outside walls and foundation. <i>Indoors:</i> Spray mites on surfaces and adjacent cracks and crevices with RTUs, or use indoor foggers.</p>	<i>Outdoors:</i> insecticidal soap <i>Indoor sprays:</i> d-phenothrin tetramethrin <i>Indoor foggers:</i> cypermethrin d-phenothrin permethrin pyrethrin tetramethrin tralomethrin

Note: Those species indicated as *nuisance pests* are primarily a problem due to their presence and are unlikely to cause harm to people, pets, buildings, or building contents. Thus, an acceptable option is to ignore them and not try to control them. Whenever possible, purchase specially prepared, ready-to-use (RTU) forms of insecticides for indoor use. Use only one insecticide from those listed. When preparing 1 gallon or more of a spray, follow the mixing directions on the pesticide label.

TABLE 5. Management Suggestions for Household Insects (cont.)

Insect	Strategies	Insecticide
Cluster flies (NHE-1) (nuisance pest)	<p>Nonchemical. Seal cracks and openings around windows, eaves, and siding. Use window screening over air-intake vents or air-conditioning systems. Seal off attic openings with screening or caulking.</p> <p>Chemical. Use dichlorvos resin strips in rooms or between storm and interior window panes. Fog lightly in rooms with RTU. Repeat spraying as needed.</p>	dichlorvos resin strips d-phenothrin tetramethrin
Cockroaches: German (NHE-3), brown-banded (NHE-4), American and Oriental (NHE-5)	<p>Nonchemical. Practice proper sanitation by keeping food properly sealed or stored in the refrigerator. Keep trash covered. Do not allow dirty dishes to accumulate. Clean frequently under refrigerator and stove, where food particles may accumulate. Eliminate hiding places, such as piles of newspapers, boxes, and papers. Caulk cracks and crevices in the foundation. Do not leave pet food out overnight.</p> <p>Chemical. Spray RTU into cracks and crevices where roaches hide. Treat under sink, refrigerator, and cabinets, and on baseboards, etc. Treatment throughout the home may be needed to control brown-banded roaches. Treatment may be supplemented with boric acid applied into out-of-sight and out-of-reach voids under cabinets and appliances.</p>	abamectin bifenthrin boric acid cyfluthrin cypermethrin diatomaceous earth d-phenothrin fipronil hydramethylnon bait hydroprene imiprothrin mint oil permethrin pyriproxifen resmethrin sulfluramid bait tralomethrin
Crickets (NHE-137): Field, house, camel	<p>Nonchemical. Cracks and crevices around windows and doors and in the foundation should be properly sealed and caulked.</p> <p>Indoors: Remove crickets by vacuuming. House lights attract both field and house crickets. Keep garbage cans clean, and empty them frequently. Keep firewood at least 1 to 2 ft from the foundation. Eliminate sources of moisture by fixing leaky pipes and modifying damp areas. Remove fallen leaves, bark mulch, and other organic debris near foundation.</p> <p>Chemical. Use outdoors to spray completely around foundation and the adjacent 1 ft of soil. Apply an RTU spray to baseboards, cracks, and door thresholds.</p>	<p>Outdoors:</p> cyfluthrin diatomaceous earth esfenvalerate permethrin <p>Indoors:</p> bifenthrin cyfluthrin cypermethrin diatomaceous earth d-phenothrin imiprothrin permethrin resmethrin tralomethrin

Note: Those species indicated as *nuisance pests* are primarily a problem due to their presence and are unlikely to cause harm to people, pets, buildings, or building contents. Thus, an acceptable option is to ignore them and not try to control them. Whenever possible, purchase specially prepared, ready-to-use (RTU) forms of insecticides for indoor use. Use only one insecticide from those listed. When preparing 1 gallon or more of a spray, follow the mixing directions on the pesticide label.

TABLE 5. Management Suggestions for Household Insects (cont.)

Insect	Strategies	Insecticide
Drain flies (NHE-91) (<i>nuisance pest</i>)	Nonchemical. Practice proper sanitation. Clean out overflow drains, drain traps, and basement drains. Keep screens in good repair. Chemical. Use chemicals only after solving sanitation problems. Pour rubbing alcohol or drain cleaner into overflow drain and main drain to eliminate maggots.	
Earwigs (NHE-142) (<i>nuisance pest</i>)	Nonchemical. Remove plant debris, organic mulch, and boards from around buildings. <i>Indoors:</i> Remove by vacuuming. Caulk cracks and crevices around windows and doors and in the foundation. Chemical. Apply outdoors as a foundation spray. <i>Indoors:</i> Spray RTU into cracks and crevices.	<i>Outdoors:</i> cyfluthrin esfenvalerate permethrin <i>Indoors:</i> bifenthrin cyfluthrin cypermethrin diatomaceous earth d-phenothrin permethrin resmethrin tralomethrin
Elm leaf beetles (NHE-82) (<i>nuisance pest</i>)	Nonchemical. Seal cracks and crevices around windows and other openings to prevent entry. <i>Indoors:</i> Remove by vacuuming. Chemical. Spray nearby Chinese elm trees during the summer to reduce the number of beetles that come into homes in the fall.	<i>Bacillus thuringiensis tenebrionis</i> carbaryl
Fleas (NHE-107)	Nonchemical. <i>Indoors:</i> With hot, soapy water, launder pet bedding and rug areas used by pets. Vacuum thoroughly to remove lint and dust around baseboards and cracks where flea eggs and larvae accumulate. Thoroughly clean furniture in areas that pets frequent. <i>Outdoors:</i> Eliminate vegetation that serves as a harborage for the native mammal population (carriers of fleas). Prevent pets from resting under the house, and exclude mammals by screening attic and eave entrances. Chemical. <i>Pets:</i> Treat pets directly as needed. <i>Indoors:</i> For infestations in the home, spray RTU on carpets and rugs and into cracks and crevices in areas where fleas are observed. Vacuum rugs and upholstered furniture thoroughly about 30 minutes after spraying. <i>Outdoors:</i> Apply to lawn.	<i>Pets:</i> carbaryl dust naled <i>Outdoors:</i> carbaryl <i>Indoors:</i> methoprene + permethrin, pyrethrin, or tetramethrin pyriproxifen
Flies (NHE-16): Houseflies, gnats, midges	Nonchemical. Proper sanitation is important. Dispose of refuse frequently and prevent the accumulation of rotting or decaying vegetation. Keep screens in good repair. Fly strips and flyswatters also can be effective. Chemical. Use RTU to spray around garbage cans and other resting sites.	d-phenothrin mint oil tetramethrin

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TABLE 5. Management Suggestions for Household Insects (cont.)

Insect	Strategies	Insecticide
Honeybees (NHE-141)	<p>Nonchemical. Caulk cracks and crevices during the winter or early spring to prevent nest building. Seal attic openings, air-intake vents, and air-conditioning systems with window screening. Swarms usually leave within a week without treatment.</p> <p>Chemical. Dust wall openings where bees are entering. Remove and destroy nests and honey. Treat wall openings at dusk or dawn. Wear protective clothing.</p>	carbaryl dust
Lice (NHE-105): Human, head, crab, body	<p>Nonchemical. Practice proper personal hygiene. Avoid using other individuals' combs, hats, towels, and hairbrushes. Bedding and clothing should be changed and washed frequently. Sanitation of locker rooms and proper laundering help reduce the incidence of lice. Premise treatments are rarely needed for head lice because they die within 48 hours without human contact. Crab louse is usually transmitted through intimate sexual contact.</p> <p>Chemical. Apply to body according to label directions. Do not get shampoo or chemical in the eyes. Consult a physician if eyes are affected.</p>	<p>Kwell shampoo (available only by a physician's prescription)</p> <p>malathion permethrin pyrethrin</p>
Mites, bird	<p>Nonchemical. Remove empty bird nests on buildings. Kill mites with soap and water at nest location, on windowsills and frames, and on interior surfaces.</p> <p>Chemical. Spray building where nest was located. Spray windowsills and frames.</p>	d-phenothrin tetramethrin
Mites, human: Human scabies, human itch mites (NHE-135)	<p>Chemical. Consult a physician. Follow label directions.</p>	<p>Kwell lotion (available only by a physician's prescription)</p> <p>pyrethrin</p>
Mosquitoes (NHE-94, -132)	<p>Nonchemical. Keep screens in good repair. Cover flues and chimneys during the summer months. Eliminate resting places such as tall grass, weeds, shrubbery, and vines from around the home. Eliminate rainwater-collecting items such as old tires, pans, cans, and buckets. Weekly, drain plastic swimming pools and birdbaths. Provide for proper water drainage around the foundation of the home. When visiting mosquito-infested areas, wear protective clothing to prevent bites. If small garden ponds are present, use Top minnows, <i>Gambusia</i> sp., or <i>Bacillus thuringiensis israelensis</i>. "Bug zappers" and ultrasonic devices have not proved to be particularly effective in controlling mosquitoes and other noxious flying insects.</p> <p>Chemical. Spray tall grass, areas around doorways, and other resting sites. Use a repellent like DEET when entering mosquito-infested areas.</p>	<p><i>Outdoors:</i></p> <p><i>Bacillus thuringiensis israelensis</i></p> <p>DEET RTU d-phenothrin malathion resmethrin</p>

Note: Those species indicated as *nuisance pests* are primarily a problem due to their presence and are unlikely to cause harm to people, pets, buildings, or building contents. Thus, an acceptable option is to ignore them and not try to control them. Whenever possible, purchase specially prepared, ready-to-use (RTU) forms of insecticides for indoor use. Use only one insecticide from those listed. When preparing 1 gallon or more of a spray, follow the mixing directions on the pesticide label.

TABLE 5. Management Suggestions for Household Insects (cont.)

Insect	Strategies	Insecticide
Pantry and cereal pests (NHE-11): Grain beetles, Indianmeal moths, flour beetles	Nonchemical. Discard infested packages. Thoroughly clean and vacuum food cabinets and shelves. Keep dry food in tightly sealed containers. Freeze pet food and birdseed for 3 to 4 days.	
Pomace flies, fruit flies	Nonchemical. Remove sources of infestation, such as apples, tomatoes, potatoes, onions, and other stored fruits and vegetables. Make sure drains and garbage disposals are clean. Remove remaining flies with commercial traps or long-necked bottles such as wine bottles laid on their sides, containing a little wine or a mixture of water, sugar, and yeast.	
Powder-post beetles (NHE-85)	Nonchemical. Avoid buying furniture or wood products that have not been stained, varnished, or properly dried. Properly paint or varnish new wood items to seal pores and to prevent egg laying. Chemical. Paint or spray infested unfinished wood with borates. Follow label directions.	borates
Silverfish (NHE-86) (<i>nuisance pest</i>)	Nonchemical. Reduce the humidity. Reduce harborage sites by caulking cracks and crevices. Eliminate silverfish food sources by storing books, papers, and linens in tightly sealed containers or cabinets. Chemical. Spray runways, baseboards, closets, and places where pipes go through the walls. Repeat treatments in 4 weeks if needed. Apply boric acid in out-of-reach areas only.	bifenthrin boric acid cyfluthrin cypermethrin diatomaceous earth d-phenothrin imiprothrin permethrin resmethrin tralomethrin
Spiders (NHE-17, -116)	Nonchemical. Keep screens in good repair and screen other openings. Caulk all seams around windows and doors. Spiders are considered beneficial, as they are predators of insects and other small animals. <i>Indoors:</i> Remove by vacuuming. Chemical. Use outdoors to spray completely around outside foundation and the adjacent 1 ft of soil. Apply RTU spray to baseboard, cracks, and door thresholds. <i>Do not use diazinon EC indoors.</i>	<i>Outdoors:</i> cyfluthrin esfenvalerate permethrin <i>Indoors:</i> bifenthrin cyfluthrin cypermethrin d-phenothrin imiprothrin permethrin resmethrin tralomethrin
Springtails (NHE-70) (<i>nuisance pest</i>)	Nonchemical. Eliminate moist areas, fallen leaves, and mulch around the home. Keep screens and doors in good repair. Allow potting soil of houseplants to dry out between waterings. <i>Indoors:</i> Reduce humidity and moisture leaks in infested areas.	

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TABLE 5. Management Suggestions for Household Insects (cont.)

Insect	Strategies	Insecticide
Swimming pool insects (NHE-103) (<i>nuisance pest</i>)	Nonchemical. Keep outside light to a minimum. Maintain proper chlorine balance in the pool. Cover pool when not in use.	Do not add insecticides to pool water.
Termites (NHE-57)	Nonchemical. Remove termite tubes connecting the soil to wood sources. Eliminate wood-to-soil contacts. Ventilate damp areas such as crawl spaces for proper drying. Use treated wood when landscaping or constructing outside structures. Cedar and redwood are somewhat resistant; termites prefer hardwoods. Chemical. Refer to termite section at the beginning of this chapter for additional information.	
Ticks (NHE-56): Brown dog ticks, American dog ticks, lone star ticks, black-legged ticks (deer tick)	Nonchemical. Keep vegetation, weeds, and brush mowed. Avoid areas where ticks are known to be present. Wear long-sleeved shirt and trousers when visiting infested areas; tuck pant legs into socks. Check for ticks on skin or clothing every few hours. Remove attached ticks by grasping with tweezers where mouthparts are attached to the skin and pulling slowly. Vacuum baseboards and cracks and crevices thoroughly to destroy eggs and immatures. Chemical. Apply spray to lawns, fencerows, roadsides, and areas not regularly mowed. Treat pets as needed. Spray or dust baseboards, cracks, and crevices around pet bedding. Use a repellent like DEET when entering tick-infested areas. Permethrin can be used on clothing.	<i>Outdoors:</i> carbaryl malathion tetrachlorvinphos 50WP <i>Pets:</i> carbaryl dust tetrachlorvinphos dust <i>Humans:</i> DEET RTU permethrin
Wasps (NHE-141), hornets, yellowjackets	Nonchemical. Keep garbage cleaned up and properly covered. Avoid indiscriminate killing of wasps, hornets, and yellowjackets, as they are considered beneficial. When picnicking, keep food properly covered or sealed. Avoid areas where yellowjackets are prevalent. Keep overripe fruit and vegetables cleaned up and away from human activity. Caulk cracks and crevices during the winter or early spring to prevent yellowjacket nests, but do not caulk opening of active nest. Chemical. For nests below ground, apply diazinon according to label, and seal opening with soil. Dust with carbaryl the wall openings where yellowjackets are entering. Spray outdoor, aboveground wasp and hornet nests with RTUs. Remove nests and destroy them. Treat nests at dusk or dawn. Wear protective clothing.	carbaryl dust d-phenothrin mint oil resmethrin

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TABLE 6. Names of Insecticides

Common name	Chemical and trade names
abamectin	<i>Avermectin B, a mixture of avermectins</i> Raid Max Roach Bait (+ hydroprene)
acephate	<i>O, S-dimethyl acetylphosphoramidothioate</i> Acephate Orthene Orthenex (+ triflorine, hexakis) Ortho Isotox (+ hexakis) Ortho Rosepride Systemic (+ resmethrin)
<i>Bacillus thuringiensis israelensis</i>	<i>bacterial toxin</i> Mosquito Attack Mosquito Dunks
<i>Bacillus thuringiensis kurstaki</i>	<i>bacterial toxin</i> B.t. Caterpillar Attack Dipel Thuricide
<i>Bacillus thuringiensis tenebrionis</i>	<i>bacterial toxin</i> Potato Shield Biological Insecticide
bifenthrin	<i>(2 methyl [1,1'-biphenyl]-3-yl) methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcy clopropane carboxylate</i> Ortho Home Defense Indoor & Outdoor Insect Killer 5 Ortho Houseplant & Garden Insect Killer Ortho Rose & Flower Insect Killer
borates	<i>disodium octaborate tetrahydrate</i> Bora-Care Jecta Tim-bor <i>sodium tetraborate pentahydrate</i> Pic Ant Control System (+ boric acid) Walgreen's Ant Control Systems
Borax	<i>sodium tetraborate decahydrate</i> Terro Ant Bait
boric acid	<i>boracic acid</i> boric acid Dr. Moss's Liquid Bait System (for ants)

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
boric acid (cont.)	Hot Shot Roach Powder Pic Boric Acid Roach Killer Revenge Liquid Bait Ant Killer Roach Powder Roach Prufe
carbaryl	<i>1-naphthyl methylcarbamate</i> Sevin
cyfluthrin	<i>Cyano (4-fluoro-3-phenoxyphenyl) methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate</i> Bayer Advanced Garden Insect Killer Bayer Advanced Garden Rose & Flower Insect Killer Bayer Advanced Home Pest Control Bayer Advanced Home Pest Control Indoor & Outdoor Insect Killer Bayer Advanced Lawn & Garden Multi-Insect Killer Bayer Advanced Multi-Insect Killer Raid Max Roach & Ant Killer (+ pyrethrins, propoxur)
cypermethrin	<i>ð-Cyano-3-phenoxybenzyl cis, trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate</i> Cyper Eight Raid Deep Roach Fogger Raid Max Deep Roach Fogger
DEET	<i>N, N-diethyl-m-toluamide</i> Cutter Off
deltamethrin	<i>ð-cyano-3-phenoxybenzyl (1R, 3R)-3-(2,2-dibromovinyl)-2,2-dimethyl cyclopropanecarboxylate</i> Bonide Delta Eight Insect Control
diatomaceous earth	<i>silicon dioxide in diatomaceous earth</i> Concern Diatomaceous Earth Crawling Insect Killer Safer Ant & Crawling Insect Killer Diatomaceous Earth SureFire Roach & Ant Killer
dichlorvos	<i>2,2-dichlorovinyl dimethyl phosphate</i> Hot Shot No-Pest Strip Revenge Bug Strip
dicofol	<i>1,1-Bis(chlorophenyl)-2,2,2-trichloroethanol</i> Kelthane
dimethoate	<i>O, O-dimethyl S-(N-methyl carbamoyl methyl) phosphorodithioate</i> Cygon Ferti-lome Ornamental & Evergreen Spray

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
disulfoton	O,O-diethyl S-[2-(ethylthio) ethyl] phosphorodithioate Bayer Advanced Garden 2 in 1 Systemic Rose & Flower Care Ferti-lome Di-Syston
d-phenothrin	3-phenoxybenzyl d-cis/trans 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate Ace House & Garden Bug Killer (+ tetramethrin) Deep 6 Flying Insect Killer (+ tetramethrin) Deep 6 House & Garden Insect Killer (+ tetramethrin) Enforcer Dust Mite Killer Enforcer Flea Killer for Carpets Enforcer Four Hour Fogger (+ tetramethrin) Ferti-lome Stinger II Wasp & Hornet Jet Spray (+ tetramethrin) Hi-Yield Roach Blaster K-Rid Flying Insect Killer (+ tetramethrin) K-Rid House & Garden Bug Killer (+ tetramethrin) Ortho Ant-Stop Ant Killer Spray (+ tetramethrin) Ortho Home Defense Home & Garden Insect Killer (+ tetramethrin) Raid Flying Insect Killer (+ allethrin) Raid House & Garden (+ allethrin) Sumithrin Walgreens Wasp & Hornet Killer (+ tetramethrin)
d-trans allethrin	allyl homolog of cinerin I
endosulfan	hexachlorohexahydromethane-2,4,3-benzodioxathiepin oxide Thiodan
esfenvalerate	(S)- δ -cyano-3-phenoxybenzyl (S)-2-(4-chlorophenyl)-3-methylbutyrate Black Flag Roach & Ant Killer (+ prallethrin) Ortho Bug-B-Gon Multi-Insect Liquid
fenbutatin-oxide	Bis [tris (2-methyl-2-phenylpropyl) tin] oxide Ortho Rosepride Orthenex Insect & Disease Control Concentrate (+ acephate)
fipronil	[5-amino-1-(2,6-dichloro-4-(trifluoromethyl) phenyl)-4-(1,R,S)-trifluoromethyl) sulfinyl]-1H-pyrazole-3-carbonitrile] Combat Quick Kill Formula (ant bait) Combat Quick Kill Formula (roach bait)
halofenozide	Benzoic acid, 4-chloro-,2 benzoyl-2-(1,1-dimethylethyl) hydrazide GrubEx Ortho Grub-B-Gon
<i>Heterorhabditis bacteriophora</i>	<i>insect-attacking nematode</i>
hexakis	same chemical as fenbutatin-oxide Orthenex (+ triflorine, acephate) Ortho Isotox (+ acephate)

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
hydramethylnon	<i>tetrahydro-5,5-dimethyl-2(1H)-pyrimidinone (3-[4-(trifluoromethyl) phenyl]-1-(2-[4-(trifluoromethyl) phenyl]-ethenyl)-2-propenylidene) hydrazone</i> Combat Outdoor Ant Killing Granules Combat Plus Roach Killing Gel Combat Roach Killing Gel Combat Source Kill (roach bait)
hydroprene	<i>ethyl-3,7,11-trimethyl dodeca-2,4 dienoate</i> Raid Max Plus Roach Bait (+ abamectin)
imidacloprid	<i>1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine</i> Bayer Advanced Lawn Season-Long Grub Control Merit
imiprothrin	<i>[(2,5-dioxo-3-(2-propynyl)-1-imidazolidinyl) methyl cis-trans chrysanthemate</i> Raid Ant & Roach (+ cypermethrin)
insecticidal soap	<i>potassium salts of fatty acids</i> Concern Insect Killing Soap Reuters Aphid-Mite Attack Safer Entire Insect Killer for Trees & Shrubs (+ pyrethrins) Safer's Insecticidal Soap Safer Yard & Garden Insect Attack (+ pyrethrins)
iron phosphide	<i>iron phosphide</i> Escar-Go Sluggo
lindane	<i>Gamma-1,2,3,4,5,6-hexachloro-cyclohexane</i> Ferti-lome Lindane Borer, Leafminer & Beetle Borer Spray Ortho Borer & Leafminer Spray
malathion	<i>diethyl mercaptosuccinate, S-ester with O, O-dimethyl phosphorothioate</i> Cythion Mal-A-Cide
metaldehyde	<i>2,4,6,8-tetramethyl-1,3,5,7-tetroxocane</i> Deadline Ferti-lome Eliminate Ferti-lome Eliminate Snail, Slug, and Bug (+ carbaryl) Hi-Yield Snail & Slug Killer Pellets K-Gro Snail & Slug Bait K-Gro Snail & Slug Pellets Ortho Bug-Geta Plus Snail, Slug & Insect Killer (+ carbaryl) Ortho Bug-Geta Snail & Slug Killer Spectracide Snail & Slug Killer

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
methoprene	<i>isopropyl-1 1-methoxy-3,7,1 1-trimethyl-2,4 dodecadienoate</i> Enforcer Flea Spray (+ permethrin) Hertz Central Home Flea & Tick Killer (+ permethrin) Ortho Flea-B-Gon Total Flea Killer Indoor Fogger (+ permethrin) Ortho Total Flea Killer Indoor Spray (+ permethrin) Precor Raid Flea Killer Plus (+ tetramethrin, pyrethrins)
mint oil	<i>mint oil</i> Victor Poison Free Ant & Roach Killer (+ sodium lauryl sulfate) Victor Poison Free Flying Insect Killer (+ sodium lauryl sulfate) Victor Poison Free Wasp & Hornet Killer (+ sodium lauryl sulfate)
naphthalene	<i>naphthalene</i> Moth Crystals
paradichlorobenzene	<i>1,4-dichlorobenzene</i> Moth Crystals
permethrin	<i>(3-phenoxyphenyl)methyl (1) cis/trans-ethenyl-2,2-dimethylcyclornopancarboxylate</i> Ace Garden Insect Killer Ace Multi-Purpose Garden & Pet Dust Acme Indoor Fogger (+ tetramethrin) Conquest Indoor & Outdoor Pest Control Dragon Lawn & Garden Protector Eight Insect Control Eight Vegetable, Fruit, & Flower Spray Eight Yard & Garden RTU Enforcer Ant Kill & Barrier Treatment (+ pyrethrins) Enforcer Four Hour Fogger (+ pyrethrins) Gordon's Home Pest Killer GreenThumb Roach, Ant & Spider Killer (+ pyrethrins) GreenThumb Home Insect Fogger (+ pyrethrins) Hi-Yield Total Release Fogger (+ pyrethrins) Hot Shot Ant Killer Plus Hot Shot Flying Insect Killer Plus (+ allethrin) Hot Shot Fogger (+ tetramethrin) Meijer Wasp & Hornet Killer (+ tetramethrin) No-Pest Multi-Purpose Garden Dust Ortho Bug-B-Gon Multi-Purpose Garden Dust Ortho Home Defense Hi-Power Indoor Insect Fogger (+ pyrethrins) Permanone Raid Ant Killer (+ pyrethrins) Raid Fumigator Raid Wasp & Hornet Killer (+ tetramethrin) Raid Yard Guard Outdoor Fogger Formula VII

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TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
permethrin (cont.)	Revenge Home Exterminator Formula II (+ pyrethrins) Spectracide 3X Insect Control Spectracide Ant Shield Home Barrier Granules Spectracide Bug Stop (+ pyrethrins) Spectracide Carpenter Ant Killer Spectracide Immunox Plus Spectracide Flying Insect Killer (+ pyrethrins) Spectracide Terminate Supplemental Spot Treatment Spectracide Yard & Patio & Mosquito Spray Walgreens Roach & Flea Fogger (+ pyrethrins)
petroleum oil	<i>petroleum oil</i> Bonide All Seasons Horticultural Oil Spray Bonide All Seasons Spray Oil Dormant & Summer Oil Spray Dormant Oil Spray Ferti-lome Scalecide Hi-Yield Dormant Spray Horticultural spray oil Ortho Volck Oil Spray Pratt Scalecide SunSpray Ultrafine Oil
propoxur	2-(1-methylethoxy) phenyl methylcarbamate Baygon Bonide Termite & Carpenter Ant Control Enforcer Battle Stations for Roaches Walgreens Roach Control Systems
pyrethrins	<i>principally from plant species Chrysanthemum cinariaefolium</i> Ace Flower & Vegetable Insect Spray Concern Multi-Purpose Insect Killer Conquest Insecticide Concentrate Dragon Easy Garden Ferti-lome Quik-Kill Ferti-lome Red Spider & Mite Spray Flowtron Indoor and Outdoor Insect Killer Gordon's Garden Guard Hot Shot Kitchen Bug Killer I-Bomb Meijer Rose & Flower Meijer Tomato & Vegetable Miracle Grow Bug Spray Natural Guard Natural Insect Spray Ortho Flea-B-Gon Pet Flea & Tick Killer Ortho Rose & Flower Insect Killer Ortho Tomato & Vegetable Insect Killer

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
pyrethrins (cont.)	Reuter Yard & Garden Insect Attack Roach Attack Schultz-Instant Fruit & Vegetable Insect Spray Schultz-Instant Houseplants & Garden Insect Spray Schultz-Instant Roses & Flower Insect Spray Spectracide Tomato & Vegetable Insect Spray Whitmire Ultra Guard Houseplant Insect Spray
pyriproxyfen	<i>2-[1-methyl-2-(4-phenoxyphenoxy)ethoxy] pyridine</i> Enforcer Flea Fogger (+ permethrin, pyrethrins) Enforcer Flea Spray (+ tetramethrin, d-phenothrin) Enforcer Flea Spray for Homes (+ permethrin)
resmethrin	<i>(5-benzyl-3-furyl) methyl 2,2 dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate</i> Burgess Bug Killer Burgess Insect Fog Ferti-lome White-fly & Mealybug Killer GreenThumb Yard & Patio Fogger Ortho Outdoor Insect Fogger Walgreens Flying Insect Killer (+ allethrin)
rotenone	<i>principally from the plants Derris and Cubé</i>
Sabadilla	<i>principally from the plant Schoenocaalon</i>
soybean spray oil	<i>soybean oil</i> Golden Naturál Spray Oil
<i>Steinernema carpocapsae</i>	<i>insect-attacking nematode</i> Biosafe
sulfluramid	<i>N-ethyl perfluorooctane sulfonamide</i> Hot Shot Maxattrax Ant Bait Raid Ant Baits Plus Spectracide Power Bait Ant Bait Terminate Termite Home Defense System
tetramethrin	<i>(1-cyclohexene-1,2-dicarboximido)-methyl 2,2-dimethyl-3-(2-methylpropenyl)-cyclopropanecarboxylate</i> Black Flag Flying Insect Killer (+ d-phenothrin) GreenThumb Flying Insect Killer (+ d-phenothrin) GreenThumb Wasp & Hornet Killer (+ d-phenothrin) Hot Shot Fogger (+ permethrin) Raid Flea Killer (+ pyrethrin) Spectracide Bug Stop Indoor Fogger

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 6. Names of Insecticides (cont.)

Common name	Chemical and trade names
tralomethrin	<i>(tetrabromoethyl)-2,2-dimethylcyclopropanecarboxylic acid</i> Ace Home Insect Control Ace Indoor Fogger Hot Shot Roach & Ant Killer (+ allethrin) Hot Shot Spider Killer (+ allethrin) K-Gro Home Insect Killer K-Rid Ant & Roach Killer (+ allethrin) K-Rid Home Insect Killer 4 K-Rid Roach & Flea Fogger No-Pest Indoor Fogger Spectracide Ant & Roach Killer (+ allethrin) Spectracide Ant Shield (+ allethrin) Spectracide Bug Stop Indoor & Outdoor Home Insect Control Spectracide Bug Stop Indoor Fogger Spectracide Flea & Tick Killer
trichlorfon	<i>dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonate</i> Bayer Advanced Lawn Grub Control Dylox

Note: This table lists the common names of insecticides used in the tables, followed by the italicized chemical names and the capitalized commercial trade names. The insecticides listed in parentheses will add some control to the situation, but the one in the heading will be as effective or more effective in controlling the pest. Some products may be available under a variety of trade names that are not listed in this table. Be sure to read the label. The label on the container always lists these products by the common name or chemical name.

TABLE 7. Conversion Table for Small Quantities of Insecticide

1 level tablespoon = 3 level teaspoons
1 fluid ounce = 2 tablespoons
1 cup = 8 fluid ounces or 16 tablespoons
1 pint = 2 cups
1 quart = 2 pints or 32 fluid ounces
1 gallon = 4 quarts or 128 fluid ounces



CHAPTER 2



CONTROLLING WEEDS IN HOME LAWNS

Weeds are plants growing where they are not wanted. Weeds are usually controlled in home lawns because they distract from the overall appearance of the turf. High-quality lawns normally are judged by their uniformity. Uniformity is the combined visual effects of lawn grass leaf width (texture), color, density, and growth habit. Weeds often have different leaf shapes, sizes, flowers, colors, or growth habits than lawn grasses and, thus, reduce uniformity within a turf area. Several turfgrasses, such as tall fescue or creeping bentgrass, may be weeds when growing in Kentucky bluegrass or fine-fescue turf areas because these grasses reduce the uniformity of the turf.

Weed Life Cycles

Weeds usually have one of three life cycles: annual, biennial, or perennial.

Annual weeds live for a single season. There are two types of annuals, and both reproduce by seeds. Cool-season annuals (also known as winter annuals) germinate in late summer or fall, are dormant during the winter, flower in spring or early summer, and then die. Chickweed (*Stellaria media*) and henbit (*Lamium amplexicaule*) are examples of cool-season annual weeds. Warm-season annuals (also known as summer annuals) germinate during spring or summer, flower, and die at the end of that growing season. Crabgrass (*Digitaria* spp.), goosegrass (*Eleusine indica*), spurge (*Euphorbia supina*), knotweed (*Polygonum aviculare*), and yellow foxtail (*Setaria glauca*) are examples of warm-season annual weeds.

Biennial weeds live for two seasons. During the first growing season, these weeds remain in a vegetative phase. Following a cold treatment (vernalization), biennial weeds bolt, flower, set seed, and die during the second growing season. Wild carrot (*Daucus carota*) and bull thistle (*Cirsium vulgare*) are examples of biennial weeds in turf.

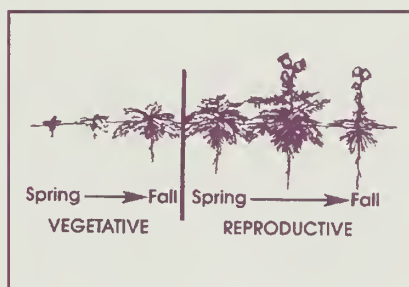
Perennial weeds live for multiple seasons and flower more than once. Perennial structures (rhizomes, stolons, crowns, entire plants, nutlets, or roots) survive from year to year. Wild garlic (*Allium vineale*), yellow nutsedge (*Cyperus esculentus*), quackgrass (*Elytrigia repens*), ground ivy (*Glechoma hederacea*), and violet (*Viola* spp.) are examples of perennial weeds.

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.



Warm-season annual weeds



Biennial weeds



Perennial weeds

Lawn Weed Control

There are several lawn weed-control methods homeowners can employ. The first method is weed prevention, the second is the use of environmental and cultural management, and the third is the use of chemical weed controls.

Prevention

When planting turfgrasses, it is important to use soil, seed, sod, plugs, or sprigs that are as free of weeds as possible. If you are bringing in soil for landscape applications, attempt to buy soil that does not contain weed seeds or vegetative plant parts that may develop into future weed problems. Inspect seed labels to determine the quantity of weed or crop seed within the seed. Avoid planting annual ryegrass in any permanent turf setting; although annual ryegrass is generally short-lived, it may persist as a weed grass for more than one growing season. Examine sod, plugs, or sprigs for the presence of weeds before purchase. In general, purchase and use high-quality soil, seed, sod, plugs, or sprigs at the time of lawn establishment. The high quality may be somewhat more costly in the short run but provides an attractive lawn with fewer weeds over the long run.

Reducing weed spread from areas adjacent to established turf also can help prevent weed infestations. Mowing weeds before they flower can reduce seed movement into turf areas.

Environmental and Cultural Management

Another defense against weed infestations in turfgrass is to produce a dense stand of healthy turf. Quality turf can compete well with weeds. It is best achieved by providing a good growing environment and by properly preparing planting soils, planting high-quality turfgrasses suitable for the given situation, and using proper cultural practices (mowing, watering, fertilizing, and cultivating).

Excessive traffic physically damages turf and also compacts soil; thin turf, which can result, is prone to weed invasion. Perennial ryegrass and tall fescues have the ability to tolerate wear better than most other cool-season grasses. Where appropriate, use these grasses in high-traffic areas. Compaction reduces the quantity of large, gas-containing pore spaces in soils. Some weeds (for example, goosegrass and knotweed) are more tolerant of low-oxygen conditions in soil than are most turfgrasses. Cultivate these areas so that the turf can better compete with weeds.

Along with compacted soils, other unfavorable growth environments also can create growing conditions in which weeds are better adapted than turf. Shade that reduces light quantity and quality favors weeds (for example, creeping Charlie and common chickweed) rather than turf. Prune or remove trees to allow more light to reach the growing area; this also can increase air movement and decrease disease problems. Soils that are excessively wet or dry create environments in which weeds often grow better than does turf. If possible, provide external and internal drainage to remove excess water from the turf root zone. Also, supplemental irrigation may be used in dry periods. In general, try to create growing environments that favor your lawn instead of weeds.

Cultural defense against turfgrass pests begins with the proper preparation of planting soils and the planting of selected turfgrass cultivars. Proper planting of turfgrasses includes planting bed preparation; timing; and use of high-quality, adequate seed, sod, plugs, or stolons. It is important to pay particular attention to soil drainage, moisture retention, fertility, and pH. A properly prepared planting bed meets a turf's growth demand; this can reduce future problems associated with soils that are too wet or dry, infertile, prone to compaction, full of debris, or too acidic or alkaline.

When selecting turfgrasses, it is important to consider the turf's use, its growth environment, its desired appearance, the management it is to receive, and its resistance to pests. Plant high-quality turfgrasses that are most likely to give you the

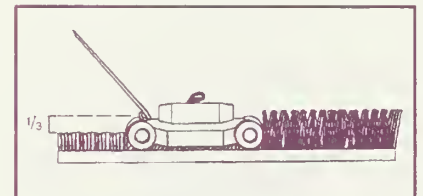
TABLE 1. Recommended Turfgrass Planting Combinations for Specific Midwest Sites and Applications

Setting	Turfgrass
Full sun	Kentucky bluegrass blend (3 or more Kentucky bluegrass cultivars OR >80% Kentucky bluegrass/perennial ryegrass OR tall fescue blend (3 or more tall fescue cultivars) OR bermudagrass (southern portion of Midwest) OR buffalograss (very-low-maintenance areas) OR zoysiagrass (southern portion of Midwest)
Dry shade	30–50% blend of shade-tolerant Kentucky bluegrasses + 50–70% fine-leaf fescues OR tall fescue blend OR zoysiagrass (southern portion of Midwest)
Wet shade	70% or more rough bluegrass + remainder in blend of shade-tolerant Kentucky bluegrasses

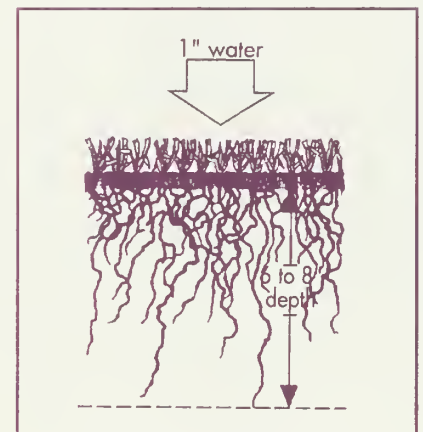
outcome you desire. We recommend that mixes (combinations of two or more species of turfgrass) and/or blends (combinations of two or more cultivars of the same species) be planted to reduce overall turfgrass disease potential and provide grasses capable of tolerating varied sites (Table 1).

Following turfgrass planting and selection, mowing, irrigating, fertilizing, and cultivating can be used to reduce pest problems. Proper mowing is critical to turfgrass health and appearance because turfgrasses that are mowed too short become open, inviting weed invasion. They also may develop inadequate root systems, which allow plants to succumb more readily to insect and disease pests. If turfgrasses are allowed to grow too tall, they can appear unkempt and coarse in texture; turfgrass playability on athletic fields can also be affected. Basic mowing recommendations include frequent mowing at the tallest height recommended for the specific turf appearance and use (Table 2).

Irrigating turfgrasses is also important. Overwatered turf may grow too rapidly; develop shallow root systems; and be prone to invasions of weeds, insects, and diseases. Underirrigated turf may become open and sparse, develop a poor appearance, and allow weed invasions. Under most circumstances, water deeply and infrequently,



$\frac{1}{3}$ rule



Proper watering means watering deeply to the depth of the root system.

TABLE 2. Suggested Mowing Heights for Commonly Used Turfgrass Species

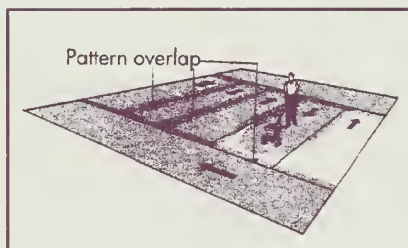
Turf species	Mowing height (in inches)
Buffalograss	2 to 3
Creeping bentgrass	$\frac{1}{4}$ to $\frac{3}{4}$
Fine-leaf fescue	2 to 3
Kentucky bluegrass	2 to 3
Perennial ryegrass	2 to 3
Tall fescue	2 to 3
Zoysiagrass	1 to $1\frac{1}{2}$

to the depth of the root system. To maintain green, actively growing turfgrass throughout the entire season, supply 1 to 1½ inches of water per week from natural or artificial sources.

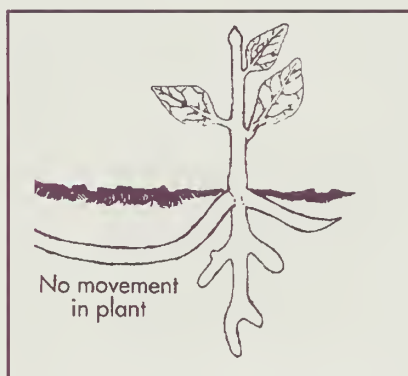
Fertilizers maintain turfgrass density, vigor, and color. Applying large amounts of nitrogen, however, can result in turfgrasses that are lush and prone to many diseases. Inadequate nitrogen fertilization leads to open turf that is readily invaded by weeds. If other minerals in the soil—especially potassium, phosphorus, iron, and sulfur—are present in adequate amounts, turf color, disease resistance, and stress tolerance can be improved. Conduct soil tests and supply these elements as recommended by the results. Lacking test results, supply a complete fertilizer in appropriate amounts and timing to capitalize on periods of active turfgrass growth.

Cultivation activities include core aeration, slicing, and vertical mowing. These activities can reduce thatch and prepare turf for overseeding. Core aeration is also useful for reducing soil compaction. Conduct cultivation activities during periods of active growth, when turfgrasses are best able to recover from these practices.

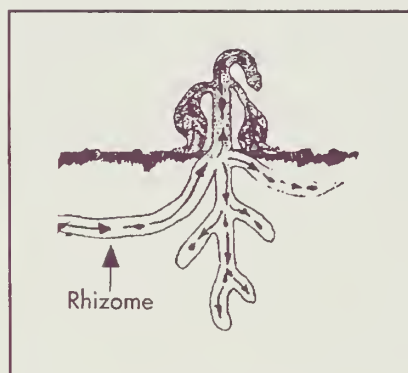
See other turfgrass-management publications available from ACES/ITCS Marketing and Distribution and from the Department of Natural Resources and Environmental Sciences at the University of Illinois.



Dry-spreader application



Contact pesticide



Systemic pesticide

Chemical Weed Controls

Although proper turfgrass planting, selection, and culture should result in adequate pest control, at times the intelligent selection and use of chemical weed controls (herbicides) may be necessary to control turf weeds. Herbicides should be used only after weed-prevention activities and proper culture have failed to produce the desired quality of turf. Avoid using herbicides as a quick fix while mismanaging your lawn.

For the most efficient weed control and safest use, be sure to read, understand, and follow all label directions before mixing and using any herbicide. A few minutes spent studying the information on the label may prevent misuse and needless accidents.

Herbicides control one or more plant species. They may be classified into one of three types (contact, systemic, or soil sterilant), depending on the nature of their activity on plants.

Contact herbicides kill plant parts covered by the chemical. *Systemic herbicides*, absorbed by plant organs and translocated throughout the plant, may be either *selective*, killing certain weeds without injuring desirable grasses, or *nonselective*, controlling all vegetation.

Glyphosate, a nonselective herbicide, is useful in renovating turfs infested with extensive populations of annual weeds. Glyphosate is also used to kill perennial weedy grasses, such as quackgrass, that cannot be controlled by selective herbicides. Because glyphosate has no residual soil activity, treated areas may be reseeded soon after application. Mecoprop is a selective herbicide used to control broadleaved weeds in turf.

Soil sterilants are chemicals that render the soil toxic to all plant life. How long the soil remains sterile depends on the material used, the rate of application, and the prevailing environmental conditions that affect decomposition of the herbicide in the soil. *Soil sterilants have no place in turfgrass management*, however, they are useful in preventing plant growth under fences and in other areas that are difficult to mow.

Herbicides may be applied to prevent weeds from infesting a turf or to control weeds already present. Bensulide is a *preemergence* herbicide applied in the spring-time to prevent crabgrass. Once the weed has germinated, DSMA may be used as a *postemergence* treatment to selectively control the crabgrass invader.

Weed-Control Groups

There are three groups of chemical controls for turf weeds: annual grasses, perennial grasses and other perennial monocots, and broadleaved weeds. The most common annual grasses found in home lawns are crabgrass, yellow foxtail, goosegrass, fall panicum, and barnyardgrass. Common perennial grasses in turf include tall fescue, quackgrass, bentgrass, and nimblewill. Other perennial monocots include yellow nutsedge, wild garlic, and star of Bethlehem. Broadleaved weeds include annuals such as common chickweed or prostrate spurge and perennial weeds such as dandelions and white clover.

Perennial Grasses and Other Perennial Monocot Weeds

Perennial grassy weeds are considered to be the most difficult weed problems to deal with in lawns. Control options are limited because the weed species are biologically very similar to the lawn species. In fact, many perennial grassy weeds are not considered weeds per se but are considered desirable grasses when growing by themselves under a different set of conditions.

For example, several common perennial grasses are considered weeds when growing in Kentucky bluegrass lawns because they differ greatly in leaf width, color, or growth habit. Tall fescue is more coarse and grows in distinctive clumps when it occurs with Kentucky bluegrass. Creeping bentgrass, a very desirable turf species for golf courses, becomes a weed in bluegrass lawns because it appears as patches of finer grass, usually lighter in color. Zoysiagrass, a warm-season turf species, appears as patches of thick grass, dormant (straw-colored) for much of the spring and fall in Kentucky bluegrass or other cool-season grass lawns.

Additional perennial grasses and perennial monocot weeds are frequent weed problems. Quackgrass, a coarse species with thick underground stems (rhizomes), can be a major problem in lawns. Nimblewill, a creeping warm-season species, often appears as light-colored patches in lawns. Yellow nutsedge and wild garlic appear similar to grasses but belong to other plant families and are controlled with different herbicides.

One way to distinguish perennial grasses from annuals is the time of the year established plants are present. Perennials (other than nimblewill and zoysiagrass) appear as established green grasses early in spring, whereas most annual grasses, such as crabgrass, do not appear until late spring or early summer. Likewise, most annuals die off quickly in fall, but perennials do not.

Removing these weeds and weed patches by hand is one control option. It's important to get all of the plant, as many have underground or aboveground stems (rhizomes or stolons). The stems enable these species to spread quite readily; so, if broken or cut, they regrow.

Selective chemical control is not an option with most perennial grassy weed species. Unlike selective herbicides used on annual grasses (for example, crabgrass), nonselective herbicides used to control perennial weed grasses also may damage the lawn species. For this reason, spraying over the lawn is not suggested unless the problem is severe enough that all grasses must be killed and the lawn reestablished. Using a nonselective herbicide, such as glyphosate, you can spot-treat patches of the undesirable species. After weeds and portions of lawn die, reseed with desirable grass species. Treating in early to mid-August is generally thought of as the best timing (late July to early August for nimblewill and zoysiagrass), as late August into early September is the most favorable time for reseeding. If you are resodding the area afterwards, there is a longer period to treat the weeds. Keep in mind, however, that the weed species must be actively growing to be controlled by glyphosate. Allow 10 to 14 days to determine if weeds have been controlled completely.

Other perennial monocot weeds require different chemical controls and are difficult to control. For these weeds, consult a lawn-care professional or your local Extension office to discuss methods of chemical weed control.



Tall fescue



Quackgrass



Creeping Charlie



Buckhorn plantain



Dandelion

Broadleaved Weeds

Broadleaved weeds, such as dandelion, clover, and creeping Charlie, are weed problems in turf because they have obvious differences in leaf shape, growth habit, and flower shape and color. Trying to determine why these weeds have invaded a lawn is the first step in managing broadleaved weeds in lawns. Weeds can be indicators of underlying problems. For example, ground ivy invades lawns in shade, while knotweed may indicate soil compaction. Assorted weeds may indicate overall poor conditions for lawn grasses and/or poor management.

After identifying the weeds present, step two for controlling broadleaved weeds should be to review lawn-care practices and make adjustments as needed to ensure a good stand of grass. Sound lawn-care practices should promote a healthy, vigorous turf able to prevent and compete with weed invasions. These practices include proper selection and establishment, fertilization, watering, mowing, thatch management, and related practices. Alter the environment that may be favoring weeds, such as reducing shade or improving poor soil conditions.

The third step is removal of existing broadleaved weeds. Pulling by hand is one option; be sure to get as much of the root system as possible.

Chemical control of these weeds is most often accomplished using postemergence herbicides. These herbicides are systemic, that is, the herbicides are absorbed by the plant's organs and translocated throughout the weed. Postemergence broadleaved herbicides found in garden centers typically include 2,4-D (2,4-dichlorophenoxyacetic acid); mecoprop, or MCP, (2-(2-methyl-4-chlorophenoxy) propionic acid); or dicamba (3,6-dichloro-o-anisic acid); with two- and three-way combinations available (Table 3). Additional herbicides are available to commercial landscape-care services for use on lawns.

When using any chemical pest control, be sure to read, understand, and follow the label directions for proper use of these chemicals. If mishandled or misapplied, postemergence broadleaved herbicides may damage or kill many desirable ornamental or edible plants in the landscape.

There are general guidelines for using broadleaved herbicides on lawns. Avoid windy days, as these materials can damage many landscape and garden plants if they drift (spray droplets land off the lawn). Also avoid hot days (over 85°F) and periods when weeds are heat- or drought-stressed. It's best to have adequate soil moisture but no rain for 24 hours after application. Do not mow turf for a few days before and after application. Consider spot-treating weeds rather than broadcasting weed killer over the entire area. Use caution on newly seeded areas; wait four mowings before treating a newly seeded lawn, and wait 30 days before seeding an area treated with broadleaved herbicides. Refer to the label for potential hazards when used on lawns over the root zone of trees (such as with dicamba).

Early fall to midfall can be a good time to control cool-season annual weeds, such as henbit, and cool-season perennial broadleaved weeds, such as dandelions. Control is often good as weeds prepare for winter dormancy. Moreover, as weeds die following the herbicide application, lawns spread readily into bare areas in the cooler weather of fall. Control provided by spring and early summer applications may not be as good as that in autumn. In addition, warmer temperatures increase the chance of lawn injury. Regardless of the time of year, the best control is achieved when weeds are young and actively growing (Table 4).

Annual Grasses

In home lawns, crabgrass and other annual grassy weeds are common problems that can be treated through both chemical and nonchemical methods. Proper lawn-care practices to encourage a dense stand of vigorous grass are the best way to prevent weeds from invading. For example, mowing height can have a big impact; lawns mowed higher (over 2 inches) tend to have fewer problems with annual grasses such

TABLE 3. Postemergence Herbicide Control of Broadleaved Weeds in Turf

Weeds controlled	2,4-D	MCPP	dicamba	Combination of all three materials
Black medic	..	xO	X	X
Broadleaved plantain	X	..	..	X
Buckhorn plantain	X	..	..	X
Common chickweed	..	XX	X	X
Curly dock	xO	..	X	X
Dandelion	X	XX	X	X
Ground ivy (creeping Charlie)	..	xO	XX	X
Henbit	xO	xO	X	X
Knotweed	..	xO	X	X
Postrate spurge	..	xO	XX	X
Thistles	XX	xO	X	X
Violets ^a	..	..	..	..
White clover	xO	X	X	X
Wild garlic	xO	..	XX	X
Yarrow	xO	..	X	X
Yellow woodsorrel	xO	xO	xO	X

Note: All herbicides listed should be applied when weeds are actively growing. Turfgrass species exhibit different tolerances to these herbicides. Follow label directions for appropriate turfgrass species, rates, timing, and degree of safety when used near trees and shrubs.

.. = Lack of a rating for herbicide-weed combinations indicates that information was unavailable at time of publication.

x = Usually provides adequate weed control.

xx = Multiple applications may be necessary for control.

xO = May provide only partial weed control.

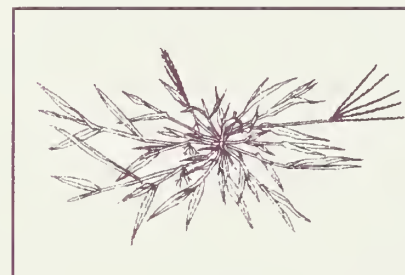
^aViolets are best controlled using broadleaved herbicides containing triclopyr. Products containing triclopyr can be applied by professional turf specialists.

as crabgrass. Close-mowed lawns tend to open up, allowing weeds like crabgrass to invade. Light, frequent watering also favors crabgrass. Crabgrass often invades areas seeded in late spring because bare soil, frequent watering, and the onset of hot weather are ideal for its growth.

In some situations, turf is grown in environments that favor weed growth and development. Many annual grassy weeds are more tolerant of wet or compacted soils or shade than are turfgrasses. Altering the growing environment to favor the turfgrass can shift the competitive edge away from weeds.

Herbicides (weed killers) are also available to manage annual weeds. Pre-emergence herbicides prevent annual grassy weeds such as crabgrass from emerging. Timing of application is very important, as the weed killer should be applied before the crabgrass emerges from the soil. Crabgrass germinates when soil temperatures are greater than 55° to 60°F for 5 to 7 consecutive days, and it can continue to germinate until soils reach 95°F. Other annual grasses germinate as soils get warmer than 60°F.

For central Illinois, mid- to late April is the suggested time for applying a pre-emergence crabgrass herbicide. In the southern portion of Illinois, make the application 1 to 2 weeks earlier, 1 to 2 weeks later in northern Illinois. If the spring is very warm, use the earlier dates; in cold, "late" springs, these materials could be



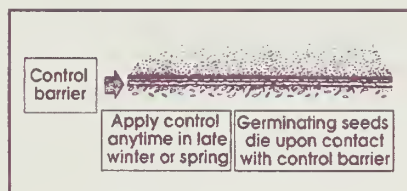
Crabgrass

TABLE 4. Timing Applications of Broadleaf Postemergence Herbicides

Weed	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
Black medic			- - - -	- - - -			- -	- - - -	
Broadleaf plantain		-	- - - -	- - - -			-	- - - -	- - - -
Buckhorn plantain		-	- - - -	- - - -			-	- - - -	- - - -
Common chickweed	-	- - - -	- - - -	- -			- - - -	- - - -	- - - -
Curly dock			- - - -	- - - -			- -	- - - -	- - - -
Dandelion		- -	- - - -	- - - -			- -	- - - -	- - - -
Ground ivy (creeping Charlie)		- - - -	- - - -	- - - -				- - - -	- - - -
Henbit		- - - -	- - - -	-				- - - -	- - - -
Knotweed		- - - -	- - - -	- - - -	- - - -	- - - -	- - - -		
Prostrate spurge		- - - -	-	- - - -	- - - -	- - - -			
Thistles		- - - -	- - - -	- - - -				- - - -	- - - -
Violets		-	- - - -	- - - -				- - - -	- - - -
White clover		- -	- - - -	- -			-	- - - -	- - - -
Wild garlic	- -	- - - -	- - - -	- - - -					
Yarrow			- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	
Yellow woodsorrel			- - - -	- - - -					

Source: Adapted from *Lawn Weeds and Their Control*, NCR Extension Publication Number 26.

Note: For more information about lawns and turf, see <http://www.turf.uiuc.edu>



Preemergence control

applied during the later timing. Using forsythia's blooming as a guide is not dependable. Many preemergence crabgrass herbicides are available in combination with lawn fertilizer at garden supply stores, so the crabgrass prevention and spring fertilization can be done at the same time.

Some herbicides may be reapplied for extended control; refer to the label for timing and rates. Core-aerifying or dethatching should be done based on label instructions. One of the management problems associated with preemergence herbicides is seeding or overseeding practices. Except for the herbicide siduron (Tupersan), preemergence annual-grass weed killers also damage germinating desirable grass seed. Siduron is often combined with starter fertilizer.

If crabgrass plants are appearing in lawns in mid- to late summer, remember that they are annual plants and die as temperatures drop in the fall. Postemergence crabgrass herbicides should be applied when crabgrass plants are very small; typically crabgrass is noticed too late for these to be effective. The suggested strategy to avoid crabgrass next season is to improve the lawn through cultural practices and consider a preemergence herbicide in the spring.

Authors

T. Voigt

*Department of Natural Resources
and Environmental Sciences*

B. Spangenberg

Extension Educator, Horticulture





CHAPTER 3



CONTROLLING WEEDS IN THE HOME GARDEN

A weed is a plant growing where it is not wanted. Weeds compete with desirable plants for water, soil nutrients, sunlight, and gaseous components of the air needed for growth. Many weeds also harbor diseases and insects that may attack plants around the home.

The first step in developing a weed-control program for your home garden is correct identification of the weed species that you wish to control. It is also important to be familiar with the weed's biology and/or life cycle when choosing a weed-control strategy.

Three general methods of weed control can be used in the home garden: (1) cultivation and mechanical removal (hoeing, pulling); (2) mulching (smothering of weeds); and (3) herbicides (weed killers). In fact, the most successful weed-control programs are those that take an integrated approach when controlling weeds.

Mechanical removal and mulching control many weeds but may not control all those present. In these cases, herbicides can be used to gain supplemental control. Additionally, it is also important to know that herbicides do not control all weeds, and there may not be a herbicide labeled for use around the plant species in your home landscape.

Prevention

Preventing future weed infestations can often eliminate weed problems. Weed seeds come into a garden by a variety of means, such as birds, wind, and even muddy boots. Fresh topsoil and soil attached to the roots of new plants added to the garden may also contain weed seeds. However these sources are likely to be of minimal concern compared to the ever-present seed bank in your garden just waiting to germinate. Certain weeds are extremely prolific seed producers. For example, one common lambsquarters plant may produce half a million seeds over the course of a season. It is key to control weeds before they flower and set seed. Doing this dramatically decreases the seed bank in your garden over time.

Cultivation and Mechanical Removal

The combination of cultivation and mechanical removal is the safest, most common, and recommended method for controlling weeds in home gardens. Because only those

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.



Cultivating by hoe

weeds that are present can be controlled, the process must be repeated several times throughout the growing season. Adequate control of weeds with this method may be difficult during vacations or busy work periods.

Shave off deeply rooted weeds with a sharp hoe while gently breaking up the soil crust. Deep tillage can cause severe injury to shallow-rooted flowers and vegetables and can bring deeply buried weed seeds to the surface, where they can germinate. Keeping equipment sharp and in good condition helps to reduce injury to desirable plants. Hoe carefully around your plants, and hand-pull weeds close to the plants.

Weeds in small areas can be controlled by wheel hoes or hand hoes; in large gardens, use power equipment such as Rototillers and garden tractors. This equipment should be set shallow when used in a garden for weed control. To prevent root injury, avoid cultivating too close to crop plants.

Mulching

Mulching controls weeds by preventing light from reaching the weed seeds or seedlings. An added benefit of mulch is that it helps keep weeds shallow-rooted and makes them easier to pull by hand. This method controls many annual weeds—those that germinate from seed each year. Perennial weeds (those that sprout each year from underground plant parts) usually must be removed by cultivation or hoeing.

The advantages of mulching include moisture conservation, prevention of soil crusting, reduction of erosion, increased soil temperatures in spring, and the ability to keep edible aboveground plant portions clean.

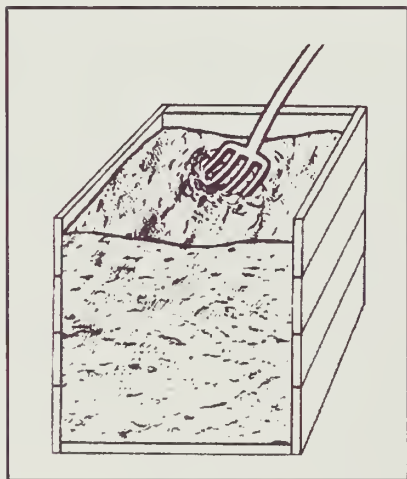
Organic Mulches

The organic materials used most frequently for mulching include plant residues such as straw or hay (free of weed seeds); crushed corncobs; various nut hulls; leaf and grass composts; peat; wood products such as sawdust, wood chips, shredded bark, and shavings; and well-rotted animal manure. Use the most economical mulch available. For good results, apply the mulch materials to a depth of 4 to 6 inches. A combination of several layers of newspaper covered by organic materials has shown promise as a summer mulch. Use papers with black ink; most black ink used for newsprint (but not colored ink) is soy based.

Applying natural mulch materials may require considerable hand labor. Most organic materials are bulky and must be hauled to the place of use, but this problem is not serious in small gardens.



Pulling weeds by hand



Compost bin

Organic mulch materials	Nitrogen required for decomposition (pounds per ton of mulch)
Cocoa pods	6.0
Corncobs (ground)	22.5
Hay, grass clippings	7.6
Peanut hulls	8.5
Sawdust (fresh)	26.0
Wheat straw	17.6

As organic mulches decompose, they return organic matter and some plant nutrients to the soil and improve soil tilth. Added benefits are the prevention of soil compaction, conservation of soil moisture, erosion control on slopes, cooler soil temperatures in summer, and added attractiveness of the garden.

When organic materials are used, you may need to add nitrogen fertilizer to prevent nitrogen deficiency in the mulched crop. With alfalfa, clover, or other legume mulches, however, excess nitrogen is released during decomposition.

Synthetic Mulches

Common synthetic mulches include polyethylene, paper, paper-polyethylene combinations, black polypropylene mats, fiberglass mats, wax-coated papers, and aluminum and steel foils.

Polyethylene film is used in a thickness of 1 to 1½ mils (1 mil = 0.001 inch) and a width of 3 to 6 feet. Black polyethylene is preferable for the home vegetable garden because it prevents light from reaching the weed seedlings. It is generally not practical to use transparent polyethylene as a full-season mulch because weeds develop under the polyethylene.

To install the mulch, press the edges down into furrows and cover them firmly with soil. A push-type, one-wheel cultivator works well to open and close furrows. The mulch may also be installed by using a rake or shovel to cover the edges with soil. Do not throw excess soil on top of the mulch.

It is better to apply synthetic mulches in crop rows than to attempt covering the entire area. The area between the rows of polyethylene mulch must be carefully cultivated or hoed.

Use of polyethylene mulch increases soil temperatures in the spring and hastens the development of some crops.

A number of "weed mat materials" (geotextiles) are readily available to homeowners. These materials may or may not be used underneath an organic mulch. When used, they prevent the weeds that germinate in the organic mulch from rooting into the soil, thus making them easy to pull.

Cultivation, mulching, or even the two in combination do not control most perennial weeds. Perennials can be controlled by removing the top growth to deplete the food (carbohydrate) supply in the underground storage tissues. This method may suppress the growth of perennial weeds, but completely eradicating the weeds with this method requires frequent recutting of the top growth.

Ground Covers

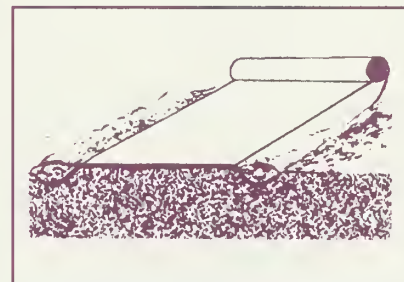
Reducing the amount of bare soil in the garden and in your landscape, in turn, reduces the number of weeds present. As the canopy of your flowers and vegetables closes, your weed problems are reduced. In sunny areas, it is beneficial to use plants with abundant light-blocking foliage and to plant densely.

Shady areas in your landscape, such as beneath shallow-rooted trees like maples, are difficult areas to grow turf. The result is often an unsightly mix of bare ground and weeds. A well-established ground cover can act as a living mulch by shading out weeds and keeping the soil cool. Shade-loving ground covers such as English ivy, pachysandra, and hosta can be used in areas where turf struggles to grow.

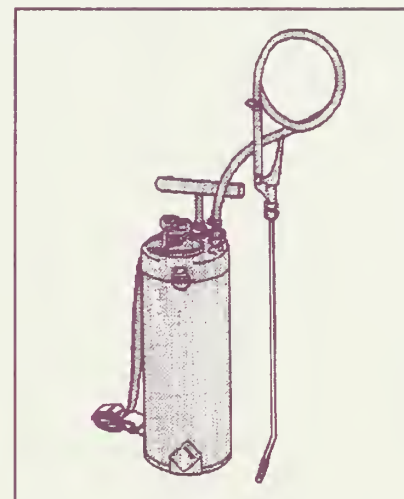
Herbicides

Using herbicides in small ornamental and vegetable gardens containing several crop species is not a good practice because different flowers, vegetables, and weeds vary in their tolerance to herbicides. Some herbicides may remain in the soil longer than one growing season and may kill or injure some species the following year (especially if excessive rates are used). Ideally, a specific herbicide should be used for each crop species; but most people have small areas of several species in their gardens, making it impractical and expensive to buy the several herbicides that would be needed.

Application must be controlled carefully when a herbicide is used on small areas. For serious weed problems, it is often thought that if a little more herbicide is applied, then weed control will be better. The fallacy of this approach is that increased herbicide application rates often result in damage to desirable plants. A low-percentage granular formulation is suggested for small garden areas.



Black polypropylene cover



Hand can sprayer

CAUTION: Check the container label very carefully for rates of material to use and application techniques. Applications must be accurate and uniform. Excessive amounts may cause injury to the current or subsequent crops.

Application techniques vary depending on the use of a preemergence or post-emergence herbicide. Preemergence herbicides are applied before weeds emerge because they control weeds as they germinate. These herbicides need to be placed where germinating seeds are—either by shallow cultivation or watering, depending on label directions. Postemergence herbicides are applied to the foliage of weeds and must remain on the weed foliage for several hours to be effective. If rain falls shortly after application, re-treatment may be necessary. Postemergence herbicides should be applied on warm, sunny days when weeds are actively growing.

For the home gardener who prefers not to remove weeds by hand, Dacthal, Devrinol, and Treflan are preemergence herbicides labeled for a number of ornamental and vegetable species. These herbicides may not be the most effective for a large planting of an ornamental, fruit, or vegetable species. Herbicides for these large plantings are listed in “Weed Control for Commercial Vegetable Crops” and “Managing Weeds in Landscape Plantings and Nursery Crops” in the *Illinois Agricultural Pest Management Handbook* and the *Commercial Landscape and Turfgrass Pest Management Handbook*, respectively (revised annually).

Herbicides may be sold under several trade names. If you cannot identify the trade names on the container, look on the label for the common name or the chemical name of the active ingredients. The trade names listed in this publication are for products commonly used in Illinois. Products of identical content that are marketed under other trade names may be equally effective. For more complete information on the registered use of herbicides discussed in this chapter, consult “Managing Weeds in Landscape Plantings and Nursery Crops” in the *Commercial Landscape and Turfgrass Pest Management Handbook*.

Preemergence Herbicides

DCPA (Dacthal) is a preemergence herbicide that controls very small weed seedlings soon after the weed seeds germinate. It does not control weeds that have emerged prior to application. The herbicide is most effective when rainfall occurs or the soil is irrigated within 2 to 3 days after application of the herbicide. Weeds that have already emerged should be removed before DCPA is applied.

DCPA is the best multipurpose herbicide for home-garden use. It is available as a 75 percent wettable-powder and as a 5 percent granular formulation. DCPA may be used for annual grass control in lawns; on a number of species of flowers; and on strawberries, broccoli, brussels sprouts, cauliflower, cabbage, dry and snap beans, cucumbers, squash, melons, collards, kale, mustard greens, turnips, garlic, onions, potatoes, sweet potatoes, yams, tomatoes, eggplants, peppers, and horseradish.

Do not use DCPA on beets, bugleweed, button pink, carnation, germander, geum, mesembryanthemum, pansy, phlox, sweet William, and telanthera.

A one-time application to all species is not always possible in a garden of flowers or vegetables because some plants in early growth stages are susceptible to injury. It is preferable to use DCPA at seeding or transplanting time if the species is adapted for it. When application must be delayed, remove emerged weeds, and then apply DCPA to prevent further weed development. Consult the container label for the appropriate application time.

DCPA is effective in controlling annual grasses that are a problem in the spring. Broadleaved weeds must be removed mechanically. Due to production difficulties, DCPA has become difficult to locate and purchase.

Napropamide (Devrinol) is a preemergence herbicide labeled for a wide range of herbaceous and woody plants. It should be incorporated into the soil by mechanical means or irrigation. Control existing weeds before applying napropamide.



Yellow foxtail



Large crabgrass

Napropamide may be used in asparagus, tomatoes, peppers, strawberries, tree fruits, nuts, shrubs, and shade trees. It controls annual grasses such as barnyardgrass, crabgrass, fall panicum, and goosegrass. Broadleaved weeds that can be controlled by napropamide include carpetweed, purslane, lambsquarters, and pigweed.

Trifluralin (Preen, Treflan) is used in soybean production in Illinois, and it is widely available. It can be purchased as a liquid with 4 pounds of active ingredient per gallon for large areas or as a low-percentage granular form for smaller areas.

Trifluralin may be used for weed control in green, lima, and dry beans; broccoli; brussels sprouts; cabbage; cauliflower; carrots; kale; mustard greens; okra; peas; peppers; tomatoes; turnip greens; apricots; cherries; grapes; peaches; and plums. Trifluralin can be used to control weeds around evergreens, trees, shrubs, and many established annual and perennial flowers. Do not use trifluralin on sweet corn, strawberries, bramble fruits, or blueberries because injury may result.

Trifluralin must be moved into the soil soon after application to prevent loss of the chemical from the soil surface. A Rototiller or similar equipment should be used to mix trifluralin with the soil to a depth of 3 to 4 inches. When it is impractical to mix trifluralin with the soil mechanically, all emerged weeds should be removed and the herbicide incorporated into the soil by rainfall or sprinkle irrigation.

The correct amount of trifluralin to use depends on the soil type. The appropriate amounts are shown on the container label.

Trifluralin is quite effective on annual grasses, but many broad-leaved weeds must be removed mechanically.

A list of preemergent herbicides recommended for application by home gardeners is presented in Table 1.

Postemergence Herbicides

Fluazifop-P-butyl (Fusilade) is a postemergence grass herbicide. It is used for controlling grass weeds in evergreens, broad-leaved ornamental plants, and broad-leaved ground covers. It should be applied with a nonionic surfactant to improve efficacy. It works best when applied to small grasses with three to five leaves.

Glufosinate (Finale) is a nonselective contact postemergence herbicide. The results of glufosinate treatment are visible sooner than those with glyphosate. The drawback to using glufosinate is that as a contact herbicide it only kills the plant



Pigweed

TABLE 1. Preemergence Herbicides Recommended for Application by Home Gardeners

Trade name and common name	Chemical name
Betasan (bensulide)	O,O-bis(1-methylethyl) S-[2-[(phenylsulfonyl)amino]ethyl] phosphorodithioate
Dacthal (DCPA)	dimethyl 2,3,5,6-tetrachloroterephthalate
Devrinol (napropamide)	NN-diethyl-2-(1-naphthalenyloxy) proprionamide
Treflan, Preen, Weed Preventer; Garden Weed Prevent; Garden Weed Prevent and Plant Food; Preen 'n Green; Preen for Groundcovers; Easy Weeder; Easy Weed 'n Green (trifluralin)	a,a,a-trifluoro-2,6-dinitro N,N-dipropyl-p-toluidine

tissue it contacts. Deep-rooted weeds are not controlled by glufosinate. They resprout from their root system and continue to be a problem.

Glyphosate (Roundup, Kleenup, Kleeraway) must be applied to the foliage of green, actively growing plants to be effective. Because glyphosate has no soil activity, it may be applied in the early spring. It may also be applied in the fall, after the edible plants have been removed from the garden but while the perennial weeds are still growing. Because glyphosate is nonselective, do not apply it to (or let it drift onto) desirable or edible plants. Be sure to read the label for complete application instructions.

Glyphosate may be used to control perennial weeds in vegetable gardens where labeled vegetable species are to be grown. It must not be applied where nonlabeled vegetable species are to be grown. If gardeners in areas that are infested with perennial weeds are willing to restrict their choice of crops for one year, this method can effectively reduce the weeds. To find out which species are labeled, check the glyphosate label or contact your local Extension office.

Sethoxydim (Vantage, Poast) is a postemergent grass herbicide used to control grasses in plantings of ornamental broad-leaved and vegetable plants. It is most effective when used to control seedling or small grasses, 3- to 5-leaf stage.

A list of postemergence herbicides recommended for application by home gardeners is presented in Table 2. As effective as herbicides are at controlling weeds, they do not control all weeds. Table 3 rates the efficacy of herbicides recommended for application by home gardeners at controlling some common weed species.

Pesticide Safety

Phenoxy and Dicamba

Phenoxy herbicides (2,4-D and others) and dicamba (Banvel) are used to control broadleaved weeds in corn, turf areas, and roadways. Most flowers, shrubs, shade trees, small fruits, tree fruits, and vegetables are susceptible to injury by these herbicides. When applying these materials, be sure that direct spray, drifting spray, or fumes do not reach susceptible plants.

Use the amine formulation of 2,4-D, which is less volatile and does not drift as easily as the esters; and apply it under calm conditions and temperatures below 80° to 85°F. A sprayer used to apply phenoxy herbicides or dicamba on grass should not be used to apply other pesticides on gardens. Phenoxys usually cannot be cleaned out of sprayers thoroughly enough to avoid injury to broadleaved plants.

TABLE 2. Postemergence Herbicides Recommended for Application by Home Gardeners

Trade name and common name	Chemical name
Fusilade, Over-The-Top Grass Killer; Ornamec 170; Grass-B-Gon Grass Killer; KICK-OUT; Bermudagrass Killer (fluazifop-P-butyl)	Butyl(R)-2[4[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoate
Finale (glufosinate)	2-amino-4-(hydroxymethylphosphinyl) butanoic acid
Vantage, Poast (sethoxydim)	2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)-propyl]-3-hydroxy-2-cyclohexen-1-one
Roundup, Kleenup (glyphosate)	N-(phosphonomethyl) glycine

TABLE 3. Efficacy Ratings of Herbicides Recommended for Application by Home Gardeners^a

Weed	Preemergence herbicide				Postemergence herbicide			
	Bensulide	Dacthal	Napropamide	Trifluralin	Fluazifop	Glyphosate	Glufosinate	Sethoxydim
Barnyardgrass	G	F	G	G	G	G	F	G
Crabgrass	G	G	G	G	G	G	F	F-G
Goosegrass	G	F	G	G	G	G	F	G
Quackgrass	..	..	..	N	G	G	P	F
Bindweed	..	..	..	..	N	F	P-F	N
Chickweed	F	G	G	G	N	G	..	N
Dandelion	..	..	..	..	N	P-F	..	N
Galinsoga	P	N	F	F	N	G	..	N
Groundsel	..	F-P	F	P	N	G	..	N
Henbit	..	..	..	..	N	F-G	..	N
Lambsquarters	F	..	F	G	N	G	G	N
Nightshade	N	..	N	N-P	N	G	G	N
Nutsedge	N	..	N	N	N	P	P	N
Oxalis	N	F	P	F	N	G	..	N
Pigweed	F	..	G	G	N	G	G	N
Purslane	F	F	G	G	N	G	..	N
Ragweed	N	..	N	N-P	N	F-G	G	N
Spurge	P	G	..	G	N	..	..	N
Sowthistle	..	..	..	..	N	..	..	N
Canada thistle	..	..	..	..	N	G	P	N
Velvetleaf	N	..	N	N-P	N	G	G	N

G = Good

F = Fair

P = Poor

N = No control expected

^aHerbicide control ratings are based on product labels, the authors' experience, and information received from Marshal McGlamery, Department of Crop Sciences, and John Masiunas, Department of Natural Resources and Environmental Sciences.

Soil Deactivation

If a garden area becomes contaminated with a persistent herbicide or a soil sterilant, this area can be decontaminated by applying activated carbon to inactivate the herbicide. See *Horticulture Fact Sheet VC-15-81*, "Testing for and Deactivating Herbicide Residues," available from Horticulture Facts, University of Illinois, 1105 Plant Sciences Laboratory, 1201 S. Dorner Drive, Urbana, IL 61801, (217)333-0350. The first copy is free, additional copies 25 cents each.

Disposal of Pesticide Containers and Surplus Pesticides

Use pesticides safely. Read the labels. If pesticides are handled or applied improperly, or if unused containers are disposed of improperly, injury can occur to humans, domestic animals, desirable plants, pollinating insects, and fish or other wildlife. Water supplies also can become contaminated. Use pesticides only when needed, and handle them with care. Follow directions, and heed all precautions on container labels.

Store all pesticides in a cool, dry, locked storage area so that they are not accessible to children, unknowledgeable persons, or animals. Do not dispose of pesticides through sewage systems or where they can run off into drainage ditches or bodies of water. Haul them or have them hauled to a sanitary landfill for burial.

Never place aerosol cans on a stove or heater or near any source of heat that might exceed 120°F. Store in a cool place—not in the hot sun. Have empty aerosol cans hauled away and buried by experienced disposal crews. Do not incinerate aerosol cans.

Classification of Herbicides

The U.S. Environmental Protection Agency classifies herbicides for *general use* or *restricted use*. An Illinois resident wishing to use a herbicide classified for restricted use must be certified as a private or commercial pesticide applicator by the Illinois Department of Agriculture. Your local Extension office can give you details on this program. No herbicide discussed in this article has been classified for restricted use.

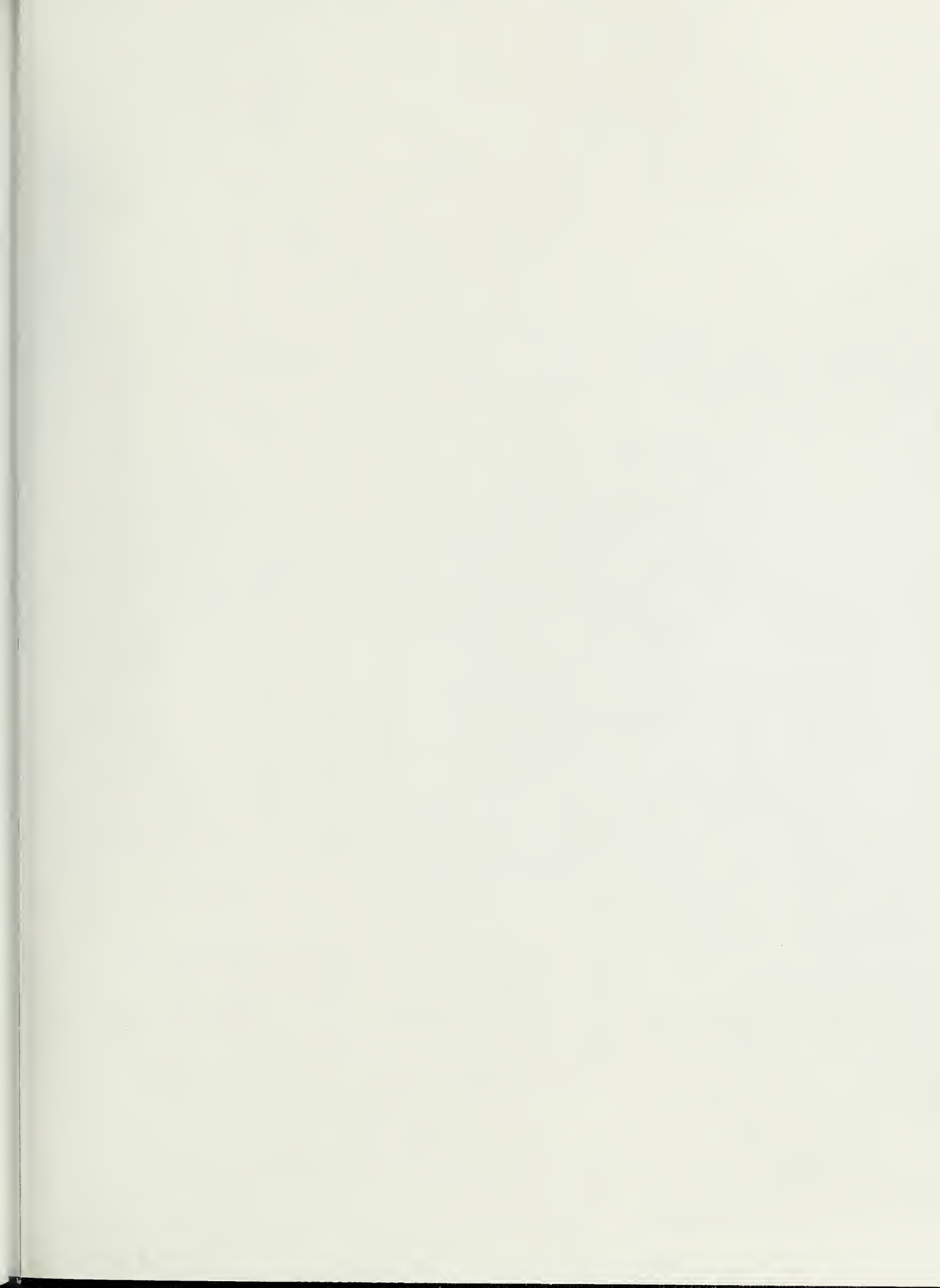
Authors

D. Williams

*University of Illinois Arboretum
and Department of Natural Resources and Environmental Sciences*

M. Wiesbrook

Department of Natural Resources and Environmental Sciences





CHAPTER 4



MANAGING PLANT DISEASES IN THE HOME LANDSCAPE

Diagnosis

The first step in an effective disease-management program is proper identification of the problem. This step is often the most difficult as well. It is important to gain a broad knowledge of the various diseases that are likely to occur on a host, as well as the non-disease problems that may have similar symptoms. At the very least, start with a good library of reference books to which you can refer. Keys to help with diagnosis, as well as a list of disease fact sheets, are provided in this chapter.

Plant diseases are either *noninfectious* (also referred to as abiotic) or *infectious* (also referred to as pathogenic). Noninfectious diseases are caused by environmental or cultural conditions, often involving some type of stress. Examples include iron chlorosis, improper watering, or extremes in weather conditions.

Infectious diseases are caused by *pathogens*, living agents that cause disease and may spread from plant to plant. Four types of pathogens cause most infectious diseases of plants: fungi, bacteria, viruses, and nematodes. Plant pathogens, generally microscopic in size, cannot be seen with the unaided eye. The plants they infect, however, develop *symptoms* that can be seen and that provide clues to the type of pathogen and disease present. Examples of infectious diseases include black spot of rose, dollar spot of turf, and anthracnose of many trees. Examples of symptoms might include wilting, leaf spots, and reduced or abnormal growth.

Whether a disease is infectious or noninfectious may be determined by looking at many different species in the same area. Disease pathogens usually infect certain plant species or closely related species, so if different species show similar symptoms, or stress, then a noninfectious cause is more likely. Improper conditions, or stress, affect many different species. Also, the noninfectious diseases can occur very rapidly as conditions change (for example, when an overnight temperature change causes plants to wilt), whereas infectious disease pathogens generally develop more slowly.

Be alert for multiple causes contributing to plant decline. Often symptoms caused by improper growing conditions, chemical injury, or environmental stress are similar to symptoms caused by infectious disease pathogens. Plants under stress are more susceptible

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to infectious disease agents, so the disease problem may be secondary to the cause of the stress. Be sure to keep an open mind and gather all the facts before making a diagnosis.

Before You Spray...

Once you have identified the problem, it is important to consider all your options before reaching for the sprayer. We strongly recommend that you learn the basics of the disease you are dealing with and read through the integrated pest management section of this handbook (Chapter 7) before you use a pesticide. Far too often, plant diseases occur due to poor site selection, temporary conditions that favor the pathogen, or mismanagement of the plant's environment. As a result, fungicides may be applied too late to do any good; and, in some cases, the real problem is never addressed.

Sometimes, pesticide applications are necessary. The intent of this chapter is to provide a list of registered pesticides, as well as references to other disease-management information so that you may choose the appropriate methods and proper product for the disease encountered. It is not the intent of the authors to promote chemical controls nor to promote one product over another.

Some products are available to commercial applicators but not to homeowners. If the product is a restricted-use pesticide (RUP), special licensing is required to purchase and apply it. However, most pesticides are not RUPs, but rather they are packaged in large quantities that make them inappropriate for most homeowners to purchase due to safe storage and disposal issues. Although there are many effective pesticides in the homeowner market, labeled for a wide range of plants and diseases, not all plants and diseases are covered. In such cases, it may be necessary to seek the help of a commercial pesticide applicator. Considering the equipment and time it takes to apply pesticides properly, you may find that the expertise of a certified commercial applicator is well worth the money.

In some cases, the authors have grouped related plants for which the diseases and pesticide recommendations are nearly identical. Before purchasing and using any pesticide, carefully read the instructions and information provided in the product label to be certain that it is safe and legal to apply it to the plant or site you wish to spray.

Although the nonchemical control measures change little over the years, pesticide names, formulations, labels, and recommendations may change annually. **It is your legal responsibility to verify that you are using the product according to its label:** Check the label for changes each time you buy a pesticide. The pesticides listed in this chapter are approved by the U.S. Environmental Protection Agency as of October 1, 2000, to the best of our knowledge. The handbook will be updated when a significant number of pesticides available to the homeowner have label changes.

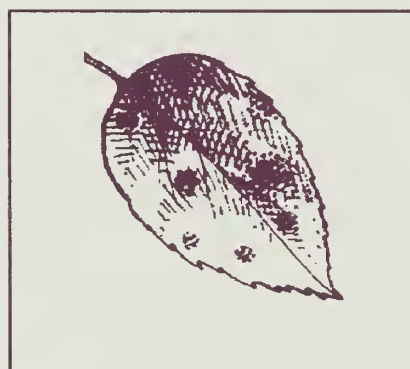
How to Use This Chapter

Table 1

A series of fact sheets discussing specific diseases of plants is available from the Department of Crop Sciences at the University of Illinois. The fact sheet series is called *Report on Plant Disease (RPDs)*. Each fact sheet describes one disease or a group of diseases and discusses host plants, environmental conditions necessary for disease, details on the pathogen, and disease-management suggestions. The RPDs are an excellent source of information on nonchemical disease control. If resistant plant varieties or cultivars are available, they are usually listed in the RPD. For additional information, many diseases listed in Tables 2, 4, and 6 refer to a particular RPD in Table 1. Only RPDs concerning turf, ornamental plants, and fruit trees are listed in this chapter.



Disease-free seed



Infected leaf

Table 2

This table categorizes turf diseases that a homeowner might encounter, arranged according to the season in which the disease is most common. Use these seasons and temperature ranges as guides only—several early season turf diseases can be found well into spring. Pesticide options are listed in the middle column, while timing and application instructions are provided in the right column, along with a reference to more information (RPD) about the pest.

Tables 3 and 5

As previously mentioned, correct identification of a disease problem is the first step in disease management. There are literally hundreds of books available on the subject of disease identification of ornamental plants. Tables 3 and 5 attempt to present simple keys to disease identification based on symptomology. Table 3 provides a key for diseases of flowers and other nonwoody plants. Use this for hosts that include annuals, perennials, and biennials that do not have a woody stem. Table 5 provides a similar key for plants with woody stems, including trees, shrubs, and some vines. These tables are meant to serve as a guide or aid in identification. Fact sheets or reference books will often be necessary to make a correct diagnosis. In some cases, you may need help from a diagnostician. Your local University of Illinois Extension office can assist you with plant and pest diagnostics by providing fact sheets and by directing you to local or regional Extension educators, state specialists, or the University of Illinois Plant Clinic (www.cropsci.uiuc.edu/research/clinic/clinic.html). In addition, your local Extension office is equipped to submit samples to a statewide diagnostics system called "Distance Diagnosis."

Tables 4 and 6

These tables list nonchemical and chemical controls for use against the common diseases found on flowers and other nonwoody ornamental plants (Table 4), as well as the woody plants (Table 6), found in Illinois. Pesticide options are listed in the middle column, while timing and application instructions are provided in the right column, along with a reference to more information (RPD) about the pest. Viral diseases are not listed because chemical controls are not effective against the viruses. In a few cases, a disease is listed even though no chemical is available for control. This was done intentionally to provide information about reference material and to point out that the disease was not mistakenly skipped.

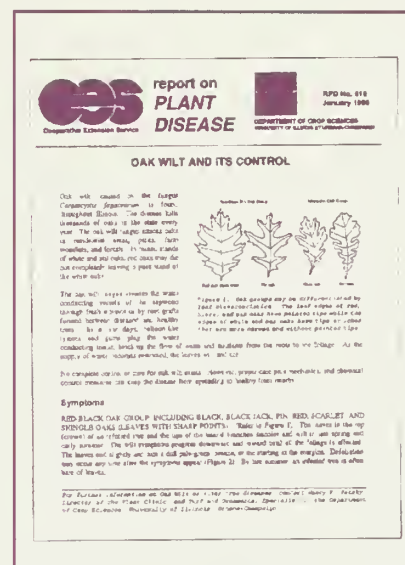
Table 7

Table 7 provides more information about each pesticide listed in Tables 2, 4, and 6. Look to this table for information about the full trade name, active ingredient, pesticide mobility, and company name.

Authors

B. Paulsrud and N. Pataky

Department of Crop Sciences



Report on Plant Disease

TABLE 1. *Report on Plant Disease Series*

Report on Plant Disease (RPDs) publications are available on the Internet (<http://www.ipm.uiuc.edu/urban/index.html>) at no charge, through your local University of Illinois Extension office, or from the Department of Crop Sciences at

Department of Crop Sciences
Plant Pathology Extension
N-533 Turner Hall
1102 S. Goodwin Ave.
Urbana, IL 61801
(217)333-8375

for \$1.00 each. Please make check payable to the University of Illinois.

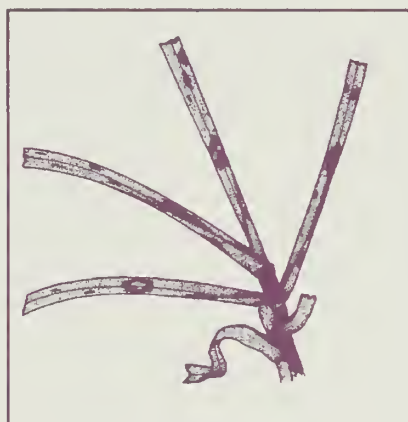
The date in parentheses indicates the most recent update. An asterisk indicates an *RPD* that has one or more color images.

Grasses and Turf

- 400 Recommendations for the Control of Diseases of Turfgrasses (3/89)
- 401* Slime Molds (1999)
- 402* Turfgrass Disease Control (1995)
- 403* Fairy Rings, Mushrooms, and Puffballs (1998)
- 404* Snow Molds of Turfgrasses (1997)
- 405* Helminthosporium Leaf Crown and Root Diseases of Lawn Grasses (1999)
- 406 Powdery Mildew of Turfgrasses (4/86)
- 407* Sclerotinia Dollar Spot of Turfgrasses (4/86)
- 408 Summer Patch and Necrotic Ring Spot of Lawns and Fine Turfgrasses (9/92)
- 409* Leaf Smuts of Turfgrasses (1998)
- 410 Pythium Blight of Turfgrasses (10/92)
- 411* Rhizoctonia Diseases of Turfgrasses (5/86)
- 412* Rusts of Turfgrasses (2000)
- 413 Red Thread and Pink Patch of Turfgrasses (1986)
- 414 Bacterial Wilt and Decline of Turfgrasses (10/87)
- 415 Yellow Tuft on Downy Mildew of Turfgrasses (4/88)
- 416* Anthracnose of Turfgrasses (9/88)
- 417 Minor Leaf Spot and Blight Diseases of Turfgrasses (10/88)

Ornamentals

- 600 Fungal Leaf Spots of Black Walnut (6/87)
- 601* Leaf Diseases of Mountain-Laurel (1998)



Diseased grass

TABLE 1. *Report on Plant Disease Series (cont.)*

602*	Armillaria Root Rot of Trees and Shrubs (2000)
603*	Iron Chlorosis of Woody Plants: Cause and Control (1996)
604*	Cytospora Canker of Spruce (1996)
605	Leaf Rusts of Poplars and Willows in the Midwest (2/90)
606	Phomopsis Canker and Dieback of Russian Olive (6/87)
607*	Bacterial Disease of Geraniums (4/90)
608	Virus Diseases of Geranium (9/89)
609*	Tulip Fire or Botrytis Blight (2000)
610	Black Spot of Rose (10/87)
611	Powdery Mildew of Roses (3/88)
612	Gladiolus Viruses (8/83)
613	Leaf Spots, Anthracnose, and Scab of Pansy and Violet (9/83)
614	Common Viruses of Orchids (5/90)
615	Damping-off and Root Rots of House Plants and Garden Flowers (2/88)
616	Bacterial Diseases of Anthurium, Dieffenbachia, Philodendron, and Syngonium (5/90)
617*	Powdery Mildews of Ornamentals (7/87)
618*	Oak Wilt and Its Control (2000)
619	Fasciation, or Leafy Gall (4/91)
620*	Leaf Scorch of Woody Plants (1997)
621*	Anthracnose Diseases of Shade Trees (1997)
622*	Phomopsis Twig Blight of Juniper (1999)
623	Botrytis Blight or Gray Mold of Ornamental Plants (1/90)
624*	Needle Blights and Needle Casts of Pines (1999)
625*	Sphaeropsis Blight or Diplodia Tipblight of Pines (1997)
626	Rose Cane Cankers (5/90)
627	Hollyhock Rust (2/82)
628	Iris Leaf Spot (4/82)
629	Oedema or Corky Scab (1998)
630	Rose Rusts (4/89)
631	Red Spot, Leaf Blotch of Peonies (4/82)
632	Rose Viruses (9/88)



Diseased leaf

TABLE 1. *Report on Plant Disease Series (cont.)*

634	Tulip Breaking or Mosaic (9/90)
635	Snapdragon Rust (7/82)
636*	Canker and Dieback Disease of Woody Plants (1997)
637	Leaf Spot or Blight of Hawthorn (7/87)
638*	Firethorn (Pyracantha) Scab (2000)
640*	Stem Blight of Vinca Minor (1995)
641*	Decline and Dieback of Trees and Shrubs (1996)
642*	Wood Rots and Decay (1999)
647*	Dutch Elm Disease and Its Control (2000)
648	Leaf Spot Diseases of Shade and Ornamental Trees in the Midwest (5/88)
649*	Pachysandra Leaf and Stem Blight (2000)
650	Fusarium Wilt Diseases of Herbaceous Ornamentals (2/88)
651	Gladiolus Corm Rots (11/83)
652*	Leaf Spot Diseases of English Ivy (11/83)
653	Pepperomia Disease (4/88)
654	Mosaic Diseases of Iris (4/88)
655	Common Leaf Diseases of Zinnia (10/87)
656	Bacterial Wetwood and Slime Flux of Landscape Trees (4/89)
657	Downy Mildew of Snapdragons (12/88)
658	Geranium Rust (1/89)
659	Bacterial Leaf Spot of Begonia (2/89)
660	Elm Yellows or Phloem Necrosis and Its Control (1998)
661	Cytospora Canker of Poplar and Willows (5/90)
662	Witches' Broom of Hackberry (7/89)
663*	Oak Leaf Blister (1999)
664*	Phytophthora Root Rot or Wilt of Rhododendrons and Azaleas in the Midwest (2000)
665	Tomato Spotted Wilt Virus (4/91)
666	Rose Rosette Disease (10/91)



Fire blight

Tree Fruits

- 800* Cherry Leaf Spot (1995)
- 801* Fire Blight (1999)

TABLE 1. Report on Plant Disease Series (cont.)

802*	Cedar-Apple and Related Rusts (1997)
803*	Apple and Crabapple Scab (1997)
804*	Brown Rot of Stone Fruits (1999)
805*	Peach Leaf Curl and Plum Pockets (1999)
806	Perennial Canker of Peach (10/84)
807	Cultural Practices to Control Diseases in Home Fruit Plantings (1/91)
808	Stem-pitting Disease of Stone Fruits (6/89)
809*	Black Knot of Plums and Cherries (2000)
810	Bacterial Spot of Stone Fruits (9/88)
811	Scab of Peach, Nectarine, Plum and Apricot (9/88)
812	Phytophthora Collar Rot of Apple (1988)
813	Botryosphaeria Canker and Fruit Rot of Apple (10/84)
814*	Black Rot of Apple (1999)
815*	Sooty Blotch and Flyspeck of Apple (1999)
816*	Powdery Mildew of Apple (1998)
817	Necrotic Leaf Blotch of Golden Delicious Apples (10/84)

Miscellaneous

1003	The Weather and Plant Diseases (8/89)
1004	Problems of Mixing Pesticides (11/88)
1005	Plant Damage from Air Pollution (4/86)
1006*	Crown Gall (1999)
1008	Sclerotinia Disease, White Mold or Watery Soft Rot (10/89)
1010*	Verticillium Wilt Disease (1997)
1100*	Collecting and Shipping Soil Samples for Nematode Analysis (1996)
1101	Root-knot Nematodes (1993)
1102*	Foliar Nematode Diseases of Ornamentals (2000)
1103*	Lesion Nematodes (10/91)
1104*	Pine Wilt Disease (1998)
1106*	The Ectoparasitic Nematodes of Illinois (1997)
1108	Nematode Parasites of Turfgrass (2000)

TABLE 2. Products Labeled for Turfgrass Diseases

Turfgrass diseases and when they typically appear	Labeled pesticides ^a	Comments ^a
Cold weather (<32° to 45°F); usually winter		
Snow molds (gray snow mold; pink snow mold/Fusarium patch)	<i>Pink snow mold:</i> Bonide Bonomyl, Dragon 3336, Ferti-lome Halt. <i>Gray snow mold:</i> Bonide Fung-onil, Dragon Daconil, Ortho Daconil.	Spray recurring problem areas just before snowfall, and repeat once or twice during the winter when snow is absent. Continue to mow in the fall until the grass stops growing. Avoid excessive nitrogen application in the fall. Fusarium patch can continue up to about 60°F. All turf species may be affected. See RPDs 400, 404.
Cool weather (45° to 60°F); usually early spring or late fall Powdery mildew	Ferti-lome Systemic, Immunox.	Spray, at labeled interval, when disease is first noticed. Reduce shade and increase air circulation. Mainly affects Kentucky bluegrass and fine-leaf fescues. See RPDs 400, 406.
Red thread/pink patch	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Ferti-lome Systemic, Immunox, Ortho Daconil.	Spray, at labeled interval, when disease is first noticed. Warm, dry weather and a light application of fertilizer stop this disease. Perennial ryegrass, older Kentucky bluegrass varieties, and fine-leaf fescues are particularly susceptible. See RPD 413.
Leaf smut	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Ferti-lome Systemic, Immunox.	Make 1 or 2 applications, 14 to 21 days apart, in October or November just before the grass goes dormant. Drench fungicide into the soil with 1 inch of water immediately after application. All turf species may be affected. See RPDs 400, 409.
Warm to hot weather (60° to 75°F or greater); usually late spring, summer, or early fall Dollar spot	Bonide Bonomyl, Bonide Captan, Bonide Fung-onil, Dragon 3336, Dragon Captan, Dragon Daconil, Ferti-lome Fungicide, Ferti-lome Halt, Ferti-lome Systemic, Immunox, Ortho Daconil.	Spray, at labeled interval, when disease is first noticed. The disease can often be minimized by applying nitrogen fertilizer. Core-aerify in the spring and/or fall to reduce compaction and thatch layer. All turf species may be affected. See RPDs 400, 407.

^aRefer to Table 7 for additional product information. Temperature groups are just general guidelines. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 2. Products Labeled for Turfgrass Diseases (cont.)

Turfgrass diseases and when they typically appear	Labeled pesticides ^a	Comments ^a
Warm to hot weather (60° to 75°F or greater); usually late spring, summer, or early fall (cont.) Fairy rings (green arcs and/or rings of mushrooms)	None suggested.	Fungicides are not very effective. Green rings can be masked by following a moderate fertility program. Mushrooms may indicate decay of buried wood. See RPDs 400, 403.
“Helminthosporium” leaf spot, melting-out	Bonide Bonomyl, Bonide Captan, Bonide Fung-onil, Dragon 3336, Dragon Captan, Dragon Daconil, Ferti-lome Fungicide, Ferti-lome Halt, Immunox, Ortho Daconil.	This disease is most commonly noted when dead patches appear during the summer, but it actually begins as leaf spots during cooler weather. Spray, at labeled interval, when leaf spots first appear. Do not spray dead patches—they must be renovated. All turf species may be affected. See RPDs 400, 405.
Pythium blight	None available for homeowner use.	Reduce shade and increase air circulation. Avoid excess nitrogen and watering in the late afternoon and evening. All turf species may be affected, particularly annual bluegrass and perennial ryegrass. See RPDs 400, 410.
Rhizoctonia brown patch	Bonide Bonomyl, Bonide Captan, Bonide Fung-onil, Dragon 3336, Dragon Captan, Dragon Daconil, Ferti-lome Fungicide, Ferti-lome Halt, Ferti-lome Systemic, Immunox, Ortho Daconil.	Spray, at labeled interval, when disease is first noticed. Reduce shade and increase air circulation. Avoid excess nitrogen and watering in the late afternoon and evening. All turf species may be affected, particularly tall fescue and perennial ryegrass. See RPDs 400, 411.
Rust	Bonide Fung-onil, Dragon Daconil, Ferti-lome Systemic, Immunox, Ortho Daconil.	Spray, at labeled interval, when disease is first noticed. Typically appears when turf is under stress from drought or low mowing. Most turf species are susceptible. See RPDs 400, 412.
Slime molds	None recommended.	Mow, rake, or hose down to remove mold when seen. See RPDs 400, 401.

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TABLE 2. Products Labeled for Turfgrass Diseases (cont.)

Turfgrass diseases and when they typically appear	Labeled pesticides ^a	Comments ^a
Warm to hot weather (60° to 75°F or greater); usually late spring, summer, or early fall (cont.) Summer patch and necrotic ring spot	Consult a professional applicator.	Rake out dead patches and reseed with a mixture of turf species and/or varieties. Stress such as soil compaction, low mowing, drought, and foliar diseases makes turf more susceptible to these diseases. Core-aerify in the spring and or fall to reduce compaction. Mainly affects annual and Kentucky bluegrasses and fine-leaf fescues. See RPDs 400, 408.

^aRefer to Table 7 for additional product information. Temperature groups are just general guidelines. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 3. Disease Symptoms of Flowers and Nonwoody Ornamentals

General symptoms	Specific symptoms	Possible disease
Leaves		
Leaves show small to large definite spots that vary in size, shape, and color.	Small dark specks are present, indicating fungal fruiting bodies; spots often roundish, with dark margins.	Fungal leaf spot Scab Spot anthracnose
	Dark, water-soaked angular spots in leaves; spots later turn gray, brown, reddish brown, or black; margin usually water-soaked.	Bacterial leaf spot or blight
	Irregular, often large, dead areas in leaves.	Leaf blight or blotch Anthracnose
Leaves spotted or blighted; later covered with dusty mold growth.	Tan to gray, coarse mold.	Botrytis blight or gray mold
	White to light gray mold:	
	Powdery to mealy; easily wiped off.	Powdery mildew
	Powdery white, raised pustules on underleaf surface; may later turn yellow, then brown.	White rust
	Light gray to pale purplish downy growth on underleaf surface.	Downy mildew
	Black mold:	
	Sooty or crusty; easily wiped off.	Sooty mold or blotch
	Sooty mold inside "blisters," or galls.	Smut
Leaves with yellow to brown or black angular spots or stripes; plants stunted or bushy.	Yellow, orange, reddish orange, reddish brown, chocolate brown, or black mold in raised pustules.	Rust
		Foliar nematodes
Leaves mottled light and dark green or yellow; often stunted, curled, and crinkled.	May form an irregular light and dark green mosaic or mottled pattern.	Viruses, including mosaic, mottle, crinkle, streak, ringspot, or spotted wilt
Leaves and shoots stunted or dwarfed and erect; appear "bunchy"; younger parts uniformly yellow, sometimes red or purple.	Yellow-green or reddish brown rings, "oakleaf," "watermark," or line patterns in leaves.	Yellows Dwarf Stunt
Leaves wilt, wither, and die; may involve part or all of plant.	Discoloration inside lower stem.	Wilt disease

TABLE 3. Disease Symptoms of Flowers and Nonwoody Ornamentals (cont.)

General symptoms	Specific symptoms	Possible disease
Leaves (cont.)	Leaves wilt, wither, and die from stem or crown rot, root rot, drought or excess water, transplant shock, injury from insects or other animals, fertilizer or pesticide injury, an excess of soluble salts, frost, other mechanical injuries.	Miscellaneous diseases and injuries
Stems and branches		
Plants lack vigor; leaves are small and pale, may later wilt or turn yellow.	Seedlings collapse and die; stand is poor.	Damping-off Seed rot
	Stems of older plants are water-soaked or discolored and decayed, often just at the base.	Stem or crown rot
	Stems or branches show definitely marked, discolored (often sunken) dead areas; parts beyond may wither and die.	Canker or dieback
	Shoots are often dwarfed or aborted; leaves are distorted; cauliflowerlike growth may appear at the soil line.	Leaf gall or fasciation
	Rough, swollen gall (flesh-colored, greenish, or dark) usually found at or near the soil line.	Crown gall
Flowers		
Flowers are spotted, often wither or rot; may be covered with mold growth.		Flower or blossom blight
Flowers are blotched or streaked with white or yellow.		Mosaic or flower breaking
Flowers are greenish yellow, dwarfed, aborted, or absent.		Aster yellows
Roots, bulbs, corms, and tubers		
Plants lose vigor, often are stunted; may turn pale or yellow; tops may wilt and die back.	Roots decay; feeder roots die back; may be covered with mold.	Root rot
	Bulb, corm, or tuber decays; may be covered with mold.	Bulb, corm, or tuber rot
	Rough, roundish galls form on roots, corms, or tubers.	Crown gall
Roots damaged.	Lack of hairy roots; root browning or galling.	Nematodes

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals

Plant and disease	Labeled pesticides ^a	Comments ^a
<i>Ageratum</i>		
Cercospora leaf spot Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Orthenex-1.	Spray at budbreak, and repeat 30 days later or when disease first appears.
Rust	Immunox, Immunox Plus, Orthenex-1.	Follow label directions.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Damping-off Fungal crown and root rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Avoid overwatering. A mixture of products may be required for control. Follow label directions. See RPD 615.
<i>Ajuga</i>		
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Begin applications when mildew first appears. See RPD 617.
Fungal leaf spots Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by damp conditions. Sanitation is very important. See RPD 623.
Sclerotium (crown) rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Fungal root rots (<i>Pythium</i> , <i>Phytophthora</i>)	None identified for homeowner use.	Avoid overwatering. Follow label directions. See RPD 615.
<i>Alyssum</i>		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
<i>Artemisia</i>		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal root rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
<i>Aster, China (Callistephus)</i>		
Botrytis blight (bud and stem rot and petal blight)	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Aster, China (<i>Callistephus</i>) (cont.)		
Powdery mildew Rust	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Funginex, Immunox, Immunox Plus, Orthenex, Orthenex-1.	Begin applications when mildew first appears. See RPD 617.
Fungal leaf spots	Bonide Mancozeb, Bonide Remedy, Dragon Mancozeb.	Begin applications when disease first appears.
Rhizoctonia stem (crown) and root rot Sclerotinia (cottony) stem rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Other fungal root rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPDs 615, 650.
Baby's breath —See <i>Gypsophila</i> .		
Balsam		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Begonia		
Botrytis blight, leaf spot, and stem rot Other fungal leaf spots	Bonide Bonomyl, Bonide Copper, Bonide Mancozeb, Dragon 3336, Dragon Copper, Dragon Mancozeb, Ferti-lome Halt, Phyton 27.	Disease is favored by damp conditions. Sanitation is very important. See RPD 623.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Dragon Copper, Ferti-lome Halt, Funginex, Immunox, Immunox Plus, Ortho Lime-Sulfur, Phyton 27.	Begin applications when mildew first appears. See RPD 617.
Bacterial leaf spot	Bonide Copper, Dragon Copper, Ferti-lome Blackspot, Phyton 27.	Keep foliage protected. Avoid wetting the foliage when watering. See RPD 659.
Fungal root, stem, or crown rots	Bonide Bonomyl, Bonide Captan, Dragon 3336, Ferti-lome Halt.	Do not apply to very young seedlings. A mixture of products may be required for control. Follow label directions. See RPD 615.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
<i>Begonia</i> (cont.)		
Tuber rot	Bonide Bonomyl, Bonide Captan, Dragon 3336, Ferti-lome Halt.	Apply to clean, disease-free begonia tubers as directed; drain; and plant in well-drained soil. See RPD 615.
Bleeding heart (<i>Dicentra</i>)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
<i>Calendula</i>		
Fungal leaf spots	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox.	Begin applications when disease first appears.
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Funginex, Orthenex, Orthenex-1.	Begin applications when disease appears. See RPD 617.
Rust		
Rhizoctonia or Sclerotinia (cottony) stem and root rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Pythium and Phytophthora root rots	None identified for homeowner use.	Follow label directions. Avoid overwatering plants. See RPD 615.
<i>Canna</i>		
Rust	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears.
Fungal leaf spots		
Carnation, Pinks (<i>Dianthus</i>)		
Anthracnose	Bonide Bonomyl, Bonide Captan, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt, Hi-Yield Lime Maneb, Ortho Daconil.	Begin applications when disease first appears. Sanitary measures are important.
Alternaria branch rot and leaf spot		
Greasy blotch		
Other fungal leaf spots		
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Immunox Plus, Orthenex-1.	Begin applications when mildew first appears. See RPD 617.
Rust	Bonide Captan, Bonide Liquid Sulfur, Bonide Mancozeb, Dragon Mancozeb, Ferti-lome Sulfur, Funginex, Immunox, Immunox Plus, Orthenex, Orthenex-1.	Follow label directions.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Carnation, Pinks (<i>Dianthus</i>) (cont.)		
Botrytis blight	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt, Hi-Yield Lime Maneb, Ortho Daconil.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Rhizoctonia stem rot Fusarium root rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPDs 615, 650.
Pythium root rot Phytophthora root rot Damping-off	None identified for homeowner use.	Avoid overwatering plants. Check label for directions and limitations. See RPD 615.
Celosia		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Other fungal leaf spots and blights	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Diseases are favored by damp weather. Begin applications when disease first appears.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Chrysanthemum (Shasta and painted daisy, not Transval daisy)		
Ascochyta stem and ray blight Septoria and other fungal leaf spots Anthracnose	Bonide Bonomyl, Bonide Copper, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Captan, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Fungicide, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Hi-Yield Bordeaux, Ortho Daconil.	Diseases are favored by damp weather. Begin applications when disease first appears.
Rust	Bonide Liquid Sulfur, Bonide Mancozeb, Ferti-lome Sulfur, Immunox, Immunox Plus, Orthenex-1.	Begin applications about a week before rust is expected.
Botrytis blight or gray mold	Bonide Bonomyl, Bonide Captan, Bonide Copper, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Captan, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Fungicide, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. See RPD 623.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Chrysanthemum (Shasta and painted daisy, not Transval daisy) (cont.)		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Orthenex-1, Phyton 27.	Begin applications when mildew first appears. See RPD 617.
Fungal root, stem, or root rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPDs 615, 650.
Bacterial wilt	Ferti-lome Fire Blight, Phyton 27.	Follow label directions.
Clematis		
Ascochyta leaf spot and stem rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by rainy periods during spring and early summer.
Coleus (<i>Plectranthus</i>)		
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Orthenex-1.	Follow label directions.
Rust		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Daffodil —See <i>Narcissus</i> .		
Dahlia		
Botrytis flower blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Disease is favored by damp conditions. Begin applications when disease first appears. See RPD 623.
Fungal leaf spots and blights		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Funginex, Immunox, Orthenex, Orthenex-1.	Begin applications when mildew first appears. See RPD 617.
Fungal crown and root rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPDs 615, 650.
Daisies —See <i>Chrysanthemum</i> or <i>Gerbera</i> .		

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
<i>Daphne</i> Phytophthora and Pythium root rots	None identified for homeowner use.	Follow label directions. Avoid overwatering plants. See RPDs 615, 650.
<i>Delphinium</i> (Larkspur) Fungal leaf spots	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears. Sanitary measures are important.
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Funginex, Immunox, Ortho Lime-Sulfur.	Begin applications when mildew is first seen. See RPD 617.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Sclerotium root and crown rot Sclerotinia wilt	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Other fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 650.
<i>Dianthus</i> —See Carnation and Sweet William.		
Dusty Miller (<i>Centaurea</i>) Fungal leaf spots	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Follow label directions.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
<i>Fuchsia</i> Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Rust	Bonide Mancozeb, Dragon Mancozeb, Immunox, Orthenex-1.	Follow label directions.
<i>Gazania</i> Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.

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TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Geranium (<i>Pelargonium</i>)		
Botrytis blight	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Fungicide, Ferti-lome Halt, Hi-Yield Bordeaux, Hi-Yield Lime Maneb, Ortho Daconil, Phyton 27.	Keep water off the foliage. Disease is favored by cool, damp conditions. Sanitation is very important. If needed, begin applications a month before first cuttings are taken. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Hi-Yield Bordeaux.	Sanitary measures are important. Disease is favored by damp conditions. Follow label directions.
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Immunox.	Follow label directions. See RPD 617.
Rust	Bonide Fung-onil, Bonide Mancozeb, Dragon Daconil, Dragon Mancozeb, Immunox, Ortho Daconil.	Begin applications when rust first appears. See RPD 658.
Downy mildew	Bonide Mancozeb, Dragon Mancozeb.	Follow label directions.
Bacterial leaf spots	Phyton 27.	Begin applications when disease first appears.
Rhizoctonia root and stem rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Blackleg (<i>Pythium</i>)	None identified for homeowner use.	Follow label directions. Avoid overwatering plants. See RPD 615.
Gerbera (<i>Transvaal</i> daisy)		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Begin applications when mildew first appears. See RPD 617.
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Sclerotinia blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions.
Phytophthora root rot	None identified for homeowner use.	Follow label directions. Avoid overwatering plants. See RPD 615.
Gladiolus		
Botrytis leaf and flower spot and corm rot	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt, Hi-Yield Bordeaux, Ortho Daconil.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
<i>Gladiolus</i> (cont.)		
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur.	Follow label directions. See RPD 617.
Fungal leaf spots	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt, Ortho Daconil.	Disease is favored by wet periods. Begin applications when the leaf spots first appear.
Fungal corm rots (<i>Fusarium</i> yellows, <i>Penicillium</i> , <i>Stromatinia</i> , and others)	Bonide Bonomyl, Bonide Captan, Dragon 3336, Ferti-lome Halt.	Soak or dust corms as directed within 24 hours after digging, or before planting. Dry and store properly. Read the label for product limitations. See RPDs 615, 650, 651.
<i>Gynura</i> (Velvet plant)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
<i>Gypsophila</i> (Baby's breath)		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Phytophthora crown and root rot	None identified for homeowner use.	Follow label directions. Avoid overwatering. See RPD 615.
Pythium root rot		
Hollyhock (<i>Alcea</i>)		
Fungal leaf spots	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Hi-Yield Bordeaux, Immunox, Ortho Daconil.	Follow label directions.
Anthracnose		
Rust	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Ortho Daconil.	For rust, begin applications, at labeled interval, when new growth appears in the spring. Sanitation is important. See RPDs 617, 627.
Powdery mildew		
<i>Hosta</i>		
Bacterial leaf spot	None identified for homeowner use.	Disease is favored by damp conditions. Follow label directions.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Hosta (cont.)		
Fungal crown and root rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Excess mulch may attract injurious insects. A mixture of products may be required for control. Follow label directions. See RPD 615.
Hyacinth (<i>Hyacinthus</i>)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal bulb rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Hydrangea —See Table 6.		
Impatiens		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Phyton 27.	Follow label directions. See RPD 617.
Bacterial leaf spot	Phyton 27.	Follow label directions.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Iris		
Fungal leaf spots	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Copper, Dragon Daconil, Dragon Mancozeb, Ferti-lome Fungicide, Ferti-lome Halt, Hi-Yield Bordeaux, Immunox, Immunox Plus, Ortho Daconil, Phyton 27.	Follow label directions. See RPDs 623, 628.
Rust		
Botrytis blossom blight		
Fungal crown, rhizome, and bulb rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPDs 615, 633, 650.
Bacterial soft rot and rhizome rot	Apply a recommended insecticide, starting when fan leaves are several inches tall.	The soft rot bacteria enter through fresh iris borer wounds and other injuries. Dig up infected plants after flowering is over; transplant disease-free, borer-free rhizomes.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Ivy, English (<i>Hedera helix</i>) Fungal spots and blights of leaf, stem, and twig	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Hi-Yield Bordeaux.	Disease is favored by wet periods during spring and early summer. Begin applications when the disease first appears. See RPD 652.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux, Phyton 27.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Bacterial leaf spot	Dragon Copper, Ferti-lome Blackspot, Phyton 27.	Follow label directions.
Fungal root and crown rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. See RPD 615.
Larkspur —See <i>Delphinium</i> .		
Liatris Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Lily (<i>Lilium</i>) Botrytis flower blight and leaf spot or blight	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt, Hi-Yield Bordeaux, Hi-Yield Lime Maneb, Ortho Daconil.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Other fungal leaf spots and blights	Bonide Bonomyl, Bonide Mancozeb, Ferti-lome Blackspot, Ortho Daconil.	Follow label directions.
Fungal root and bulb rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Some products may be used only on Easter lily. A mixture of products may be required for control. Carefully follow label directions and restrictions. See RPDs 615, 650.
Lobelia (Cardinal flower) Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Other fungal leaf spots and blights	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Lupine (<i>Lupinus</i>)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Marigold (<i>Tagetes</i>)		
Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Rust	Bonide Mancozeb, Dragon Mancozeb, Immunox, Immunox Plus, Orthenex-1.	Follow label directions.
Fungal leaf spots	Bonide Bonomyl, Bonide Copper, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt.	Follow label directions.
Phytophthora stem rot and wilt	None identified for homeowner use.	Follow label directions. Avoid overwatering plants. See RPD 615.
Rhizoctonia root rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Monarda (Bee balm)		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Narcissus (Daffodil)		
Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt.	Follow label directions. See RPD 623.
Fungal leaf spots and leaf scorch		
Fungal bulb rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions for product use before and/or after in storage. Keep bulbs dry. See RPDs 615, 650.
Nasturtium (<i>Tropaeolum</i>)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Orchid		
Botrytis flower spot or blight or gray mold	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Phyton 27.	Follow label directions. See RPD 623.
Black rot Damping-off and root rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Pachysandra		
Volutella leaf and stem blight or canker	Dragon Copper, Dragon Mancozeb, Ferti-lome Blackspot, Ortho Daconil.	The fungus is relatively weak, in that it attacks stressed plants. Avoid heavy mulching and overcrowding. See RPD 649.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Pansy, violet (<i>Viola</i>, not African violet)		
Anthracnose Scab Fungal leaf spot Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Hi-Yield Lime Maneb, Phyton 27.	Disease is favored by damp conditions. Begin applications when disease first appears, and perhaps again in the fall, before covering plants with mulch. See RPDs 613, 623.
Rust Powdery mildew	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Immunox Plus.	Spray when disease first appears. See RPD 617.
Downy mildew	Bonide Mancozeb, Dragon Mancozeb, Hi-Yield Bordeaux.	Follow label directions.
Seed rot Damping-off and seedling blights	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. Avoid overseeding and overwatering. Check label for directions and limitations. See RPDs 615, 650.
Pelargonium —See Geranium.		
Peony (<i>Paeonia</i>)		
Botrytis blight Red spot, leaf blotch, and measles	Bonide Bonomyl, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Hi-Yield Bordeaux.	Disease is favored by damp conditions. Sanitation is very important. Begin applications when new shoot growth is 2 to 4 inches tall, and continue until flowers begin to open. See RPDs 623, 631.
Phytophthora blight	Dragon Mancozeb.	Apply spray to foliage, bases of shoots, and nearby soil during rainy periods. See RPD 615.

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TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Periwinkle (<i>Vinca minor</i>)		
Phoma stem blight Other fungal leaf spots and blights	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Blackspot, Ferti-lome Halt.	Begin applications when disease first appears.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Petunia		
Botrytis blight, leaf blotch, and flower blight	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Ortho Daconil.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears.
Powdery mildew Rust	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Immunox Plus, Orthenex-1.	Begin applications when disease first appears. See RPD 617.
Fungal root and crown or foot rots (<i>Pythium</i> and <i>Rhizoctonia</i>)	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Philodendron		
Fungal leaf spots Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Ortho Daconil.	Begin applications when disease first appears. See RPD 623.
Bacterial leaf spot	Dragon Copper, Ferti-lome Blackspot, Ferti-lome Fire Blight.	Begin applications when disease first appears.
Damping-off Root and stem rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Phlox		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Funginex, Immunox, Orthenex.	Begin applications when mildew is first seen. Proper spacing of plants and plenty of sunlight are important. See RPD 617.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Phlox (cont.)		
Fungal leaf spots	Bonide Bonomyl, Bonide Copper, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux, Immunox.	Begin applications when disease first appears. See RPD 623.
Rust		
Botrytis blight		
Flower blight		
Fungal root rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Pinks—See Carnation.		
Primrose (<i>Primula</i>)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions.
Fungal root and crown rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Rose (<i>Rosa</i>)—See Table 6.		
Salvia (Sage)		
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur.	Follow label directions.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox, Immunox Plus, Orthenex-1.	Follow label directions. See RPD 617.
Rust	Immunox, Immunox Plus, Orthenex-1.	Follow label directions.
Fungal root and crown rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Scilla		
Botrytis bulb rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Sclerotinia bulb rot		
Shasta daisy—See <i>Chrysanthemum</i>.		

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Snapdragon (<i>Antirrhinum</i>)		
Anthracnose	Bonide Bonomyl, Bonide Liquid Sulfur,	Disease is favored by wet conditions. Begin applications when disease first appears. Sanitation is important.
Phyllosticta leaf and stem blight	Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur.	
Other fungal leaf spots		
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Rust	Bonide Liquid Sulfur, Dragon Mancozeb, Ferti-lome Sulfur, Ferti-lome Systemic, Immunox, Immunox Plus, Orthenex-1.	Follow label directions. Begin applications when disease first appears. See RPD 635.
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Funginex, Immunox, Immunox Plus, Orthenex, Orthenex-1.	Disease is favored by wet conditions. Begin applications when disease first appears. See RPD 617.
Downy mildew	Dragon Mancozeb.	Follow label directions. See RPD 657.
Rhizoctonia stem and root rot or wirestem	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. Avoid overwatering. See RPD 615.
Pythium and Phytophthora crown and root rots	None identified for homeowner use.	Follow label directions. Avoid overwatering. See RPD 615.
Sclerotinia root and crown rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions. See RPD 615.
Statice (<i>Limonium</i>)		
Anthracnose, Cercospora, Alternaria, and Botrytis leaf blights	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Ortho Daconil.	Spray as needed at spring budbreak. See RPD 623.
Pythium crown and root rot	None identified for homeowner use.	Follow label directions. Avoid overwatering plants. See RPD 615.
Sweetpea (<i>Lathyrus</i>)		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when mildew first appears. See RPD 617.
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Follow label directions.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Sweetpea (<i>Lathyrus</i>) (cont.)		
Fungal root and stem rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPD 615.
Sweet William (<i>Dianthus</i>)		
Heterosporium leaf spot	Bonide Remedy, Ferti-lome Systemic.	Follow label directions.
Transvaal daisy—See <i>Gerbera</i>.		
Tulip (<i>Calochortus</i>)		
Fire or Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt, Hi-Yield Bordeaux.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPDs 609, 623.
Fungal bulb rots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See RPDs 615, 650.
Velvet plant—See <i>Gynura</i>.		
Verbena		
Fungal leaf spots	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by damp conditions. Begin applications when disease first appears.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur.	Begin applications when mildew first appears. See RPD 617.
Bacterial leaf spot	None identified for homeowner use.	Follow label directions.
Rhizoctonia stem and root rot	Bonide Bonomyl, Dragon 3336.	Follow label directions. See RPD 615.
Fungal root and crown rot (<i>Pythium</i> , <i>Phytophthora</i>)	None identified for homeowner use.	Follow label directions. Avoid overwatering. See RPD 615.
<i>Vinca minor</i>—See Periwinkle.		
<i>Viola</i>—See Pansy, violet.		
Zinnia		
Alternaria leaf spot or blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Immunox, Immunox Plus.	Disease is favored by damp conditions. Begin applications when disease first appears. Sanitation is important. See RPD 655.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 4. Products Labeled for Specific Flowers or Other Nonwoody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Zinnia (cont.)		
Powdery mildew	Bonide Bonomyl, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Sulfur, Ferti-lome Fungicide, Ferti-lome Halt, Funginex, Immunox, Immunox Plus, Orthenex, Orthenex-1, Ortho Daconil, Ortho Lime-Sulfur, Phyton 27.	Begin applications when mildew first appears. See <i>RPD</i> 617.
Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. Sanitation is very important. See <i>RPD</i> 623.
Fungal root and stem rot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	A mixture of products may be required for control. Follow label directions. See <i>RPD</i> 615.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 5. Disease Symptoms of Woody Ornamentals

General symptoms	Specific symptoms	Possible disease
Leaves		
Small to large, scattered spots in various sizes, shapes, and colors	Roundish spots; may contain dark, speck-sized fungal fruiting bodies.	Fungal leaf spot
	Spots may have dark margins or drop out (shot-hole).	Spot anthracnose Scab Shot-hole
	Black, shiny spots.	Tar spot
	Irregular dead areas in leaves.	Leaf blight or blotch
	Variously colored "blisters"; leaves often partly or entirely puffy, thickened, or curled.	Leaf curl or blister
Leaves spotted or blighted; later covered with dusty mold growth	Tan to gray, coarse mold.	Botrytis blight
	White to light gray mold, powdery to mealy.	Powdery mildew
	Black mold, sooty or crusty.	Sooty mold
	Yellow, orange, reddish orange, reddish brown, chocolate brown, or black mold in raised pustules.	Rust
Leaves mottled light and dark green or yellow	Irregular mosaic pattern.	Mosaic
	Yellow-green or reddish brown rings; "oak-leaf," "watermark," or line patterns.	Ringspot
Leaves wilt, wither, and die; may involve one or many branches or entire plant.	Discoloration in outer sapwood.	Wilt disease
	Foliage appears scorched by fire; twig tips curl downward to form "shepherd's crooks."	Fire blight
	Other possible causes include wood rot; black knot; drought or excess water; transplant shock; construction damage; change in soil grade; girdling roots; injury from insects, rodents, or other animals; pesticide or fertilizer damage; winter and frost injury; salt damage; lightning or fire injury; roots in septic tanks or sewer lines; or other mechanical injuries.	Miscellaneous diseases and injuries
Leaves "scorched" at margins and tips; often later between the veins		Leaf scorch (See also Miscellaneous diseases and injuries, Specific symptoms, above.)

TABLE 5. Disease Symptoms of Woody Ornamentals (cont.)

General symptoms	Specific symptoms	Possible disease
Twigs, branches, and trunks Twigs and branches die back, usually starting at the tips; foliage commonly wilts, withers, and dies.	Discoloration in outer sapwood.	Wilt disease
	No discoloration in outer sapwood. (See Roots, Specific symptoms.)	Root rot
	Foliage appears scorched by fire; twig tips curve downward.	Fire blight
	Sap flows down trunk and branches from wounds; becomes gray to white stain on bark.	Wetwood
	Definitely marked, often sunken, swollen, flattened, or targetlike areas (cankers) in bark and outer wood of twigs and branches.	Canker or dieback
Twigs and branches die back, usually starting at the tips; foliage commonly wilts, withers, and dies.	Wood in branches or trunk decays; bracket, shelf, or mushroom fungi may form on bark surface or trunk base.	Wood rot
	Other possible causes include injury from fertilizer, pesticide, or salt; drought or excess water; lightning or fire injury; transplant shock; winter injury; excess shade; construc- tion damage; girdling roots; insect, rodent, or other animal injury; various types of mechanical damage; change in the soil grade; or chlorosis.	Miscellaneous diseases and injuries
Greatly swollen areas on twigs, branches, or trunk	Galls on <i>Prunus</i> rough and black, or olive green and velvety in spring.	Black knot
	Roundish or spindle-shaped galls on branches or trunk; often covered with yel- lowish to orange dusty masses in spring or early summer.	Rust gall
	Rough, roundish, tumorlike galls, usually at or near soil line or graft union.	Crown gall
	Large, irregular swellings anywhere on trunk or scaffold limbs of older trees.	Burr
Dense, brushy masses of stubby shoots form on branches		Witches'-broom

TABLE 5. Disease Symptoms of Woody Ornamentals (cont.)

General symptoms	Specific symptoms	Possible disease
Roots Trees lose vigor, growth slows, foliage off-color; tops (crowns) may wilt and die back.	On roots, roundish, rough, tumorlike galls, which may be several inches or more in diameter.	Crown gall
	Roots decay; feeder roots die back; mold growth under bark or over roots; usually shoestring-like black strands are evident.	Root rot
	Roots somewhat necrotic, lacking feeder roots; appear stunted or have small galls.	Nematodes (must be confirmed by soil or root analysis)
	Other possible causes include excess water; change in soil grade; construction damage; injury from fertilizer or pesticide; girdling roots; winter injury; salt, insect, or animal feeding; or wilt disease.	Miscellaneous diseases and injuries

TABLE 6. Products Labeled for Specific Woody Ornamentals

Plant and disease	Labeled pesticides ^a	Comments ^a
Acer —See Maple.		
Almond —See Cherry.		
Amelanchier (Shadbush, Serviceberry, Juneberry)		
Cedar rusts	Immunox.	Spray 3 times, starting when new growth appears in the spring. See RPD 802.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease is first seen. See RPD 617.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen. See RPD 617.
Apple —See Crabapple or Chapter 6.		
Apricot —See Cherry.		
Arborvitae (<i>Thuja</i>)		
Phomopsis needle and twig blight	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Only new growth is susceptible. Spray at bud-break and continue at labeled intervals until new growth has matured. See RPD 622.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Ash (<i>Fraxinus</i>, not Mountainash)		
Anthracnose	Bonide Bonomyl, Bonide Fung-onil,	Apply when leaf buds begin to open and again if needed. See RPDs 621, 648.
Other fungal leaf spots	Bonide Mancozeb, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Ortho Daconil.	
Powdery mildew	Bonide Bonomyl, Bonide Mancozeb,	Begin applications when disease is first seen.
Rust	Dragon 3336, Ferti-lome Halt, Immunox.	See RPD 617.
Aspen —See Poplar.		
Aucuba		
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen. See RPD 648
Azalea —See <i>Rhododendron</i> .		
Barberry (<i>Berberis</i>)		
Bacterial leaf spot and twig blight	Hi-Yield Bordeaux.	Begin applications when disease is first seen.
Fungal leaf spot and blotch	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen.
Anthracnose		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease is first seen.
Rust		
Basswood —See Linden.		
Beech (<i>Fagus</i>)		
Fungal leaf spot	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen. See RPD 648.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when mildew is first seen. See RPD 617.
Birch (<i>Betula</i>)		
Anthracnose	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Spray twice, starting at budbreak. See RPD 621.
Rust	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox, Orthenex-1.	Begin applications about a week before rust normally appears. Spray for powdery mildew when it is first seen. See RPD 617.
Powdery mildew		
Bittersweet (<i>Celastrus</i>)		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen. See RPD 617.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Bittersweet (<i>Celastrus</i>) (cont.)		
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Spray twice, starting as the leaves unfold. See RPD 648.
Boston Ivy —See Ivy.		
Boxelder —See Maple.		
Boxwood (<i>Buxus</i>)		
Fungal leaf spots and blights	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Collect and destroy fallen leaves; begin fungicide applications in spring before new growth starts. See RPD 648.
Canker or stem blight (<i>Pseudonectria</i>)	Hi-Yield Bordeaux, Hi-Yield Lime Sulfur.	Spray 4 times: (1) while dormant, after leaves have been cleaned up and before new growth starts; (2) 10 to 14 days later; (3) when growth is half complete; and (4) in autumn, when fall growth has ceased. See RPD 636.
Buckeye —See Horsechestnut.		
Buckthorn (<i>Rhamnus</i>)		
Rust	None identified for homeowner use.	Begin applications about a week before rust normally appears.
Butternut —See Walnut.		
Buttonbush (<i>Cephalanthus</i>)		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox.	Begin applications about a week before rust normally appears. Spray for powdery mildew when it is first seen. See RPD 617.
Rust		
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease is first seen. Follow label directions.
Catalpa		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox.	Begin applications when disease is first seen. See RPD 617.
Fungal leaf spots	Immunox.	Begin applications when disease is first seen. See RPD 621.
Cedar —See Juniper and Arborvitae.		

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Cherry, Peach, Nectarine, Plum, Almond, Apricot, Cherry-plum, Cherry-laurel (nonbearing trees only) Black knot	Use any product containing lime-sulfur or thiophanate methyl that is registered for use on the diseased tree.	Remove and destroy infected branches 6 to 8 inches below knot while tree is dormant. In addition, apply lime-sulfur as a dormant application after pruning; or thiophanate methyl when dormant, at pink bud, at petal fall, and 3 weeks later. If severe, spray for 2 consecutive years. See RPD 809.
Brown rot, blossom and twig blight	Bonide Captan, Bonide Copper, Bonide Liquid Sulfur, Bonide Sulfur, Dragon Captan, Dragon Copper, Dragon Sulfur, Ferti-lome Fruit Tree, Ferti-lome Sulfur, Hi-Yield Lime Sulfur, Immunox, Ortho Daconil, Ortho Home Orchard.	Spray when first blossoms open, during full bloom, and again at petal fall. See RPD 804.
Leaf blister or curl Plum pockets Witches'-broom	Bonide Fung-onil, Dragon Copper, Dragon Daconil, Hi-Yield Bordeaux, Hi-Yield Lime Sulfur, Ortho Daconil, Ortho Lime Sulfur.	Spray once in fall after leaf drop or in early spring before buds begin to swell. Applications after budbreak are ineffective. See RPD 805.
Cherry leaf spot (<i>Blumeriella</i> , syn. <i>Coccomyces</i>)	Bonide Copper, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Sulfur, Dragon Copper, Dragon Daconil, Ferti-lome Fruit Tree, Ferti-lome Sulfur, Ferti-lome Systemic, Ortho Daconil.	Spray twice at 2-week intervals, beginning at petal fall, and again 10 to 14 days after typical harvest date. See RPD 800.
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Bonide Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Hi-Yield Lime Sulfur, Immunox, Orthenex-1.	Begin applications when disease is first seen. See RPD 617.
Rust	Bonide Liquid Sulfur, Bonide Sulfur, Orthenex-1, Ortho Daconil.	Spray several times, at labeled intervals, starting about 2 weeks after petal fall.
Scab Other fungal leaf spots/blights	Bonide Bonomyl, Bonide Captan, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Remedy, Bonide Sulfur, Dragon 3336, Dragon Captan, Dragon Daconil, Ferti-lome Fruit Tree, Ferti-lome Halt, Ferti-lome Sulfur, Hi-Yield Lime Sulfur, Immunox, Ortho Daconil, Ortho Home Orchard, Ortho Lime Sulfur.	Begin applications at petal fall. See RPD 811.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Cherry, Peach, Nectarine, Plum, Almond, Apricot, Cherry-plum, Cherry-laurel (nonbearing trees only) Bacterial spot or shot-hole	Bonide Copper, Dragon Copper.	Apply once, in late dormancy up to late bud swell. See RPD 810.
Chestnut—See Horsechestnut.		
<i>Cotoneaster</i> Fire blight	Phyton 27.	If fire blight was severe last year, a dormant, early spring fungicide application may be of some benefit. Pruning out the infected tissue is important, but overstimulated plants (due to heavy pruning and high nitrogen rates) are at high risk for fire blight infections. See RPD 801.
Scab Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Begin applications at budbreak and continue, at labeled intervals, until frequent and prolonged wetting periods are uncommon (usually about July 1). See RPD 803.
Cottonwood—See Poplar.		
Crabapple, Flowering Crabapple, Apple, Pear (nonbearing trees only) Cedar rusts (apple, hawthorn, and quince)	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Sulfur, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Ferti-lome Systemic, Immunox, Orthenex-1, Ortho Daconil.	Begin applications at pink flower–bud stage and continue, at labeled intervals, 1 to 2 weeks past petal fall. Resistant varieties are available. See RPD 802.
Scab Other fungal leaf spots/blights	Bonide Bonomyl, Bonide Captan, Bonide Copper, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Mancozeb, Bonide Remedy, Bonide Sulfur, Dragon 3336, Dragon Captan, Dragon Daconil, Dragon Sulfur, Ferti-lome Fruit Tree, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Hi-Yield Bordeaux, Hi-Yield Lime Sulfur, Immunox, Ortho Daconil, Ortho Home Orchard, Ortho Lime Sulfur, Phyton 27.	Begin applications when leaves just begin to emerge from buds and continue, at labeled intervals, until frequent and prolonged wetting periods are uncommon (usually about July 1). Resistant varieties are available. See RPD 803.
Fire blight	Ferti-lome Fire Blight, Phyton 27.	See <i>Cotoneaster</i> . Resistant varieties are available.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Crabapple, Flowering		
Crabapple, Apple, Pear (non-bearing trees only) (cont.)		
Powdery mildew	Bonide Bonomyl, Bonide Copper, Bonide Liquid Sulfur, Bonide Remedy, Bonide Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Hi-Yield Lime Sulfur, Immunox.	Begin applications when disease is first seen. Resistant varieties are available. See RPD 816.
Currant, Alpine (<i>Ribes</i>)		
Anthracnose	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen. See RPD 648.
Other fungal leaf spots		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease is first seen. See RPD 617.
Dogwood (<i>Cornus</i>)		
Spot (<i>Elsinoe</i>) anthracnose	Bonide Bonomyl, Bonide Fung-onil, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Systemic, Hi-Yield Bordeaux, Hi-Yield Maneb, Immunox, Ortho Daconil.	Fairly common disease that affects only the leaf and is of little significance compared to <i>Discula</i> anthracnose. Spray just before flower bracts are fully expanded. In wet years, repeat 2 or 3 more times at labeled intervals. See RPD 621.
Dogwood (<i>Discula</i>) anthracnose	Bonide Bonomyl, Bonide Fung-onil, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Systemic, Hi-Yield Bordeaux, Hi-Yield Maneb, Immunox, Ortho Daconil.	Although rare in Illinois, this disease has been identified in the southern part of the state. High-risk situations include flowering dogwood (<i>C. florida</i>) growing in very shady and protected areas. Good plant health, sanitation, and removal of new water sprouts (during dry weather) are critical. Protect emerging leaves with a fungicide until fully expanded. See RPD 621.
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Phyton 27.	Begin applications when disease is first seen. See RPD 617.
Douglas Fir (<i>Pseudotsuga</i>)		
Rhabdocline needle cast	Bonide Fung-onil, Dragon Daconil, Ortho Daconil.	Inspect older needles in early spring. If fruiting bodies are present, consider spraying at bud-break and repeat, at labeled intervals, until new growth is fully elongated.
Swiss (<i>Phaeocryptopus</i>) needle cast		
Botrytis seedling blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Botrytis is favored by cool, damp conditions. Sanitation is very important. Follow label directions.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Elm (<i>Ulmus</i>)		
Anthracnose	Bonide Bonomyl, Bonide Mancozeb,	Begin applications when the leaf buds break open. Rake and dispose of black leaf spot–infected leaves. See RPDs 621, 648.
Black leaf spot	Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease is first seen. Follow label directions.
Elm yellows	No effective pesticides are known.	See RPD 660.
Dutch elm disease	None recommended for homeowner use.	The fungus is spread by bark beetles, root grafts, and contaminated pruning tools. Root grafting occurs between elms within 25 to 50 feet of one another. Trenching to a depth of 3 to 5 feet between trees temporarily disrupts root grafting. Remove and burn (or de-bark) the infested tree and stump as soon as possible to eliminate them as a disease source. Preventive fungicides may be injected by someone trained in injection. See RPD 647.
Euonymus		
Anthracnose	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Daconil, Ferti-lome Blackspot, Ferti-lome Halt, Ortho Daconil.	Apply at budbreak or at first sign of disease.
Scab		
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Funginex, Immunox, Orthenex, Orthenex-1, Ortho Lime Sulfur.	Begin applications when disease is first seen. See RPD 617.
Evergreens—See Douglas Fir, Fir, Juniper, Pine, Spruce, or Yew.		
Fir (<i>Abies</i>, not Douglas fir)		
Lophodermium needle cast	Bonide Mancozeb.	Spray 2 or 3 times, at labeled intervals, starting when new needles are half-grown.
Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. Mostly a greenhouse problem. Follow label directions. See RPD 623.
Rust	Bonide Mancozeb.	Where rust has been a problem, spray 2 or 3 times, at labeled intervals, beginning when new needles appear.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Firethorn —See <i>Pyracantha</i> .		
Forsythia		
Fungal leaf spots	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Disease is favored by damp conditions. Begin applications at budbreak or when disease is first seen.
Hawthorn, Red Haw (<i>Crataegus</i>)		
Entomosporium leaf spot	Bonide Bonomyl, Bonide Copper, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Immunox, Ortho Daconil.	Begin applications in early June. Extend the schedule during rainy seasons. Sanitation is important. Paul's Scarlet and English hawthorns are very susceptible. See RPD 637.
Other fungal leaf spots/blights		
Cedar-hawthorn and cedar-quince rust	Bonide Mancozeb, Immunox, Ortho Daconil.	Begin applications as flower buds begin to open and continue, at labeled intervals, 1 to 2 weeks past petal fall. Quince rust forms noticeable stem cankers that should be pruned out if practical. English hawthorn is reportedly resistant to hawthorn rust. <i>Crataegus crusgali</i> var. <i>inermis</i> and Washington hawthorn are quite susceptible to quince rust. See RPD 802.
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when mildew first appears. See RPD 617.
Fire blight	None identified for homeowner use.	See <i>Cotoneaster</i> .
Hemlock (<i>Tsuga</i>)		
Rust	None identified for homeowner use.	Where rust has been a problem, spray 2 or 3 times, beginning when new needles appear.
Hickory (<i>Carya</i>, not pecan)		
Anthracnose	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Spray 3 or 4 times, at labeled intervals, beginning at budbreak. See RPD 621.
Other fungal leaf spots/blights		
Holly (<i>Ilex</i>)		
Tar spot	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Make 2 or 3 applications, at labeled intervals, beginning when leaf buds begin to open. Rake and destroy fallen leaves.
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur.	Begin applications when disease first appears. See RPD 617.
Honeysuckle (<i>Lonicera</i>)		
Herpobasidium leaf blight	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when new growth appears.
Other fungal leaf spots		

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Honeysuckle (<i>Lonicera</i>) (cont.)		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease first appears. See RPD 617.
Horsechestnut, Buckeye (<i>Aeculus</i>)		
Anthracnose	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Ortho Daconil.	Begin applications when the buds begin to open. Thorough coverage is required for control. Resistant species are available.
Guignardia blotch		
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease first appears. See RPD 617.
Hydrangea		
Fungal leaf spots	Bonide Bonomyl, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Copper, Dragon Daconil, Ferti-lome Halt, Immunox, Ortho Daconil.	Begin applications, at labeled intervals, when new growth appears.
Hemlock-hydrangea rust	Bonide Bonomyl, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Copper, Dragon Daconil, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic.	Begin applications when disease first appears. Follow label directions. See RPD 617.
Powdery mildew		
Botrytis leaf and flower blight or gray mold	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Hi-Yield Maneb, Phyton 27.	Sanitation is very important. Disease is favored by cool, damp conditions. Begin applications when symptoms first appear. See RPD 623.
Ivy, Boston, and Virginia Creeper (<i>Parthenocissus</i>)		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Orthenex-1.	Begin applications when disease first appears. Follow label directions. See RPD 617.
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Sanitation is very important. Disease is favored by cool, damp conditions. Begin applications when symptoms first appear. See RPD 623
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Begin applications when new growth appears. Follow label directions.

Ivy, English—See Table 4.

Juneberry—See *Amelanchier*.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Juniper, Redcedar (<i>Juniperus</i>)		
Cedar rusts	Bonide Mancozeb, Dragon Copper, Orthenex-1.	Resistant cultivars are available. Begin spraying susceptible plants in early July and continue, at labeled intervals, through August. Remove galls and/or cankers to reduce infection of alternate hosts. See RPD 802.
Phomopsis twig blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Resistant cultivars are available. Begin applications, at labeled intervals, when new flushes of growth appear; protect until mature. It is important to prune and destroy dead and infected twigs. See RPD 622.
Kabatina blight	None recommended.	This disease is caused by a weak pathogen that likely infects wounds during late summer and fall and is difficult to manage with fungicides. Resistant cultivars are available.
Cercospora needle blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Copper, Ferti-lome Halt, Hi-Yield Bordeaux.	Keep new flushes of growth protected.
Botrytis blight	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux, Phyton 27.	Sanitation is very important. Disease is favored by cool, damp conditions. Begin applications when symptoms first appear. See RPD 623.
Laurel, Cherry —See Cherry.		
Leucothoe		
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease first appears.
Ligustrum —See Privet.		
Lilac (<i>Syringa</i>)		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Funginex, Immunox, Immunox Plus, Orthenex, Ortho Lime Sulfur, Phyton 27.	Begin applications when disease first appears, usually in early July. See RPD 617.
Fungal leaf spots and blights	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Begin applications when disease first appears. See RPD 648.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Lilac (<i>Syringa</i>) (cont.)		
Bacterial leaf spots and blights	Hi-Yield Bordeaux, Phyton 27.	Begin applications when disease first appears.
Linden, Basswood (<i>Tilia</i>)		
Anthracnose	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Begin applications just after budbreak and again as directed by label. See RPD 621.
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt.	Begin applications when mildew first appears. See RPD 617.
Magnolia		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears. See RPD 617.
Fungal leaf spots and blights	Bonide Bonomyl, Bonide Mancozeb, Dragon 3336, Dragon Copper, Ferti-lome Halt.	Begin applications when disease first appears. See RPD 648.
Bacterial leaf spots	Dragon Copper	Begin applications when disease first appears.
Maple, Boxelder (<i>Acer</i>)		
Anthracnose	Bonide Bonomyl, Bonide Copper, Dragon 3336, Dragon Copper, Dragon Mancozeb, Ferti-lome Halt, Hi-Yield Bordeaux.	Make 2 or 3 applications, at labeled intervals, beginning when leaf buds begin to open. Rake and destroy fallen leaves. See RPD 621.
Phyllosticta leaf spot		
Tar spot		
Other fungal leaf spots/blights		
Taphrina leaf blister	None identified for homeowner use.	Spray once in fall after leaf drop or in early spring before buds begin to swell. Applications after budbreak are ineffective. See RPD 663.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Immunox, Orthenex-1.	Begin applications when disease first appears. See RPD 617.
Mock-Orange (<i>Maclura pomifera</i>)		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox, Immunox Plus.	Begin applications when disease first appears. See RPD 617.
Rust		

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Mountainash (<i>Sorbus</i>)		
Anthrachnose Phyllosticta leaf spot Scab Other fungal leaf spots/blights	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Begin applications when leaves just begin to emerge from buds and continue, at labeled intervals, until frequent and prolonged wetting periods are uncommon (usually about July 1). See RPDs 621, 803.
Rusts	None identified for homeowner use.	Begin applications when the flower buds begin to open. Follow label directions.
Fire blight	Phyton 27.	See <i>Cotoneaster</i> .
Nectarine—See Cherry.		
Oak (<i>Quercus</i>)		
Anthrachnose (leaf-blight stage only) Other fungal leaf spots/blights	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Dragon 3336, Dragon Copper, Dragon Daconil, Ferti-lome Halt, Ferti-lome Systemic, Hi-Yield Bordeaux, Ortho Daconil, Phyton 27.	Spray just before buds open, when leaves are half-grown, and 10 to 14 days later if rainy weather persists. Remove cankered twigs where feasible. See RPD 621.
Taphrina leaf blister	Bonide Fung-onil, Dragon Daconil, Ortho Daconil.	Spray once in fall after leaf drop or in early spring before buds begin to swell. Applications after budbreak are ineffective. See RPD 663.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease first appears. Follow label directions. See RPD 617.
Oak wilt	None recommended for homeowner use.	The fungus is spread by root grafts and insects that feed on fresh wounds. Prune oaks only during late fall or when dormant. Root grafting occurs between some oak species within 25 to 50 feet of one another. Trenching to a depth of 3 to 4 feet between trees temporarily disrupts root grafting. Remove and burn (or de-bark) the infested tree and stump as soon as possible to eliminate them as a disease source. Preventive fungicides may be injected by someone trained in injection. See RPD 618.
Peach—See Cherry.		
Pear—See Crabapple.		

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Pecan (<i>Carya illinoensis</i>; nonbearing trees only)		
Anthracnose	Bonide Bonomyl, Dragon 3336, Ferti-lome	Begin applications when buds begin to open.
Spot anthracnose	Halt, Ferti-lome Systemic.	
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Ferti-lome Systemic.	Begin applications when disease first appears. See RPD 617.
Photinia		
Entomosporium leaf spot	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Systemic, Funginex, Ortho Daconil.	Begin applications when new leaf growth or disease first appears.
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox, Orthenex.	Begin applications when disease first appears. Follow label directions. See RPD 617.
Pine (<i>Pinus</i>)		
Sphaeropsis tip blight and canker (formerly "Diplodia") (In Illinois, this is mainly a problem on Austrian and Scotch pines.)	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Prune and destroy infected branches during dry weather. Mulch and water as needed to reduce stress. Spray 3 times: (1) when buds begin to elongate/swell, (2) just before new needles emerge from the sheath, and (3) 10 to 14 days later. See RPD 625.
Dothistroma needle blight (In Illinois, this is mainly a problem on Austrian pine growing in nurseries.)	Bonide Mancozeb, Dragon Copper, Hi- Yield Bordeaux.	Spray in mid-May or when needles are half- grown and again when new needles are expanded. During wet years, additional later applications may be needed. Sanitation is important; rake and remove diseased needles. See RPD 624.
Brown spot (<i>Scirrhia</i>) (In Illinois, this is mainly a problem on Scotch pine.)	Bonide Copper, Bonide Fung-onil, Bonide Mancozeb, Dragon Daconil, Hi-Yield Bordeaux, Ortho Daconil.	Spray when needles are half-grown and again 30 days later. If rainy, shorten spray interval. See RPD 624.
Sirococcus tip blight	Bonide Mancozeb, Hi-Yield Bordeaux.	Begin applications when new needles are half- grown. If rainy, shorten spray intervals.
Lophodermium and Cyclaneusma needle cast (In Illinois, these are mainly a problem on Scotch pine.)	Bonide Fung-onil, Bonide Mancozeb, Dragon Daconil, Hi-Yield Bordeaux, Ortho Daconil.	Most Lophodermium infections occur during rainy periods from mid- to late summer after new needles reach mature length. Make 3 or 4 applications, at labeled intervals, during this timeframe. If possible, applications should be made prior to rainfall. See RPD 624.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Pine (<i>Pinus</i>) (cont.)		
Pine wilt (Pinewood nematode) (In Illinois, this is mainly a problem on Scotch pine.)	No effective chemical controls available.	Remove and destroy the infested tree and other dead pines in the area immediately. Do not store infested wood as this serves as a source of future infestations. The pinewood nematode is not known to infest or survive in belowground plant parts. See RPD 1104.
Planetree—See Sycamore.		
Plum—See Cherry.		
Poplar, Aspen, Cottonwood (<i>Populus</i>)		
Anthracnose	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Ortho Daconil.	Begin applications when buds begin to open. See RPD 621.
Spot anthracnose		
Other fungal leaf spots/blights		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur.	Begin applications when disease first appears. See RPD 617.
Rust	Funginex.	Spray once or twice, at labeled intervals, beginning about 1 to 2 weeks before rust normally appears. See RPD 605.
Privet (<i>Ligustrum</i>)		
Anthracnose	Bonide Bonomyl, Bonide Fung-onil, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Immunox, Immunox Plus, Ortho Daconil.	Begin applications when buds begin to open.
Other fungal leaf spots/blights		
Powdery mildew		
	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Immunox Plus.	Begin applications when disease first appears. See RPD 617.
Pyracantha (Firethorn)		
Fire blight	Dragon Copper, Ferti-lome Blackspot, Ferti-lome Fire Blight, Phyton 27.	See <i>Cotoneaster</i> .
Scab	Bonide Bonomyl, Bonide Fung-onil, Bonide Mancozeb, Dragon 3336, Dragon Copper, Dragon Daconil, Ferti-lome Blackspot, Ferti-lome Halt, Ortho Daconil, Phyton 27.	Spray at budbreak, just before blossoms open, at petal fall, and 2 weeks later. See RPD 638.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
<i>Pyracantha</i> (Firethorn) (cont.)		
Other fungal leaf spots/blights	Bonide Bonomyl, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Ferti-lome Halt.	Begin applications when buds begin to open.
Powdery mildew	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Halt, Orthenex-1.	Begin applications when disease first appears. See RPD 617.
Quince (<i>Cydonia</i>)		
Fungal leaf spots	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Ortho Daconil.	Begin applications, at labeled intervals, when buds begin to open.
Brown rot blossom blight	Bonide Fung-onil, Bonide Liquid Sulfur, Dragon Daconil, Ortho Daconil.	Spray when first blossoms open, during full bloom, and again at petal fall. See RPD 804.
Rust	Bonide Fung-onil, Dragon Daconil, Immunox, Ortho Daconil.	Begin applications at budbreak and repeat at labeled intervals during spring rainy periods. See RPD 802.
Fire blight	None identified for homeowner use.	See <i>Cotoneaster</i> .
Redcedar—See Juniper.		
Red Haw—See Hawthorn.		
<i>Rhododendron</i> (Azalea)		
Ovulinia petal or flower blight	Bonide Bonomyl, Bonide Fung-onil, Bonide Remedy, Dragon 3336, Dragon Daconil, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Insecticide & Fungicide, Funginex, Hi-Yield Maneb, Immunox, Immunox Plus, Ortho Daconil.	Begin applications as growth starts in early spring.
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Sulfur, Ferti-lome Blackspot, Ferti-lome Halt, Ferti-lome Sulfur, Funginex, Immunox, Immunox Plus, Orthenex-1.	Begin applications when disease first appears. See RPD 617.
Fungal leaf spots Leaf, flower, and stem galls	Bonide Bonomyl, Bonide Copper, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Blackspot, Ferti-lome Halt.	Spray just before budbreak and repeat at labeled intervals through flowering.
Botrytis blight	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Ferti-lome Blackspot, Ferti-lome Halt, Phyton 27.	Botrytis is favored by cool, damp conditions. Sanitation is very important. Follow label directions. See RPD 623.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Rhododendron (Azalea) (cont.)		
Phytophthora dieback and root rot	Bonide Fung-onil, Dragon Daconil, Dragon Mancozeb, Ferti-lome Blackspot, Ortho Daconil.	Follow label directions. See RPD 664.
Rose (Rosa)		
Botrytis bud, blossom, and cane blight	Bonide Bonomyl, Bonide Captan, Bonide Fung-onil, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Captan, Dragon Daconil, Ferti-lome Fungicide, Ferti-lome Halt, Ferti-lome Rose Spray, Ferti-lome Triple, Ortho Daconil, Phyton 27.	Botrytis is favored by cool, damp conditions. Sanitation is very important. Follow label directions. See RPD 623.
Black spot Anthracnose Other fungal leaf spots/blights Cane cankers	Bonide Bonomyl, Bonide Captan, Bonide Copper, Bonide Fung-onil, Bonide Liquid Sulfur, Bonide Mancozeb, Bonide Remedy, Dragon 3336, Dragon Captan, Dragon Copper, Dragon Daconil, Dragon Sulfur, Ferti-lome Blackspot, Ferti-lome Fungicide, Ferti-lome Halt, Ferti-lome Rose Spray, Ferti-lome Sulfur, Ferti-lome Systemic, Ferti-lome Triple, Funginex, Hi-Yield Maneb, Immunox, Immunox Plus, Orthenex, Orthenex-1, Ortho Daconil, Ortho Lime-Sulfur, Phyton 27.	Begin spraying as soon as leaves emerge and continue, at labeled intervals, into September or early October. Lengthen spray intervals or skip applications altogether during dry weather. Remove and destroy (1) infected leaves during the growing season and (2) all infected tissues in fall and early spring. Resistant varieties are available. See RPDs 610, 626.
Rusts	Bonide Liquid Sulfur, Bonide Mancozeb, Ferti-lome Systemic, Funginex, Hi-Yield Lime Sulfur, Immunox, Immunox Plus, Orthenex, Orthenex-1, Ortho Lime-Sulfur.	Begin spraying at budbreak and continue at labeled intervals until the weather turns hot and dry. Remove and destroy infected tissues as with black spot. See RPD 630.
Powdery mildew	Bonide Bonomyl, Bonide Copper, Bonide Liquid Sulfur, Bonide Remedy, Dragon 3336, Dragon Copper, Dragon Sulfur, Ferti-lome Blackspot, Ferti-lome Halt, Ferti-lome Sulfur, Ferti-lome Systemic, Ferti-lome Triple, Funginex, Hi-Yield Lime Sulfur, Immunox, Immunox Plus, Orthenex, Orthenex-1, Ortho Lime-Sulfur, Phyton 27.	Begin applications when new growth appears. Thorough coverage is required. Follow label directions. See RPD 611.
Downy mildew	Bonide Mancozeb.	This disease is rarely found outside greenhouse and production areas. Follow label directions.
Russian-olive (Elaeagnus)		
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when leaves unfold. Follow label directions.

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TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Russian-olive (<i>Elaeagnus</i>) (cont.)		
Rust	Immunox.	Follow label directions.
Serviceberry, Shadbush— See <i>Amelanchier</i> .		
<i>Spiraea</i> (<i>Spirea</i>)		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Immunox Plus, Orthenex-1.	Begin applications when disease first appears. See RPD 617.
Botrytis blight	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Phyton 27.	Disease is favored by cool, damp conditions. Sanitation is very important. See RPD 623.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears.
Spruce (<i>Picea</i>)		
Rhizosphaera needle cast (In Illinois, this is mainly a problem on Colorado blue spruce.)	Bonide Fung-onil, Dragon Daconil, Ortho Daconil.	Spray when needles are half-grown (as soon as bud-caps fall off) and again when fully elongated. Chemical controls are effective if disease is caught early. At least 2 years of fungicide applications are usually required. Rake up and dispose of infected needles. Norway spruce is considered resistant.
Cytospora canker (In Illinois, this is mainly a problem on Colorado blue; Norway spruce is less susceptible.)	No effective chemical-control options.	Prune and destroy dead/dying limbs during dry weather. Reduce stress by mulching around the tree and fertilizing in the fall. Too much or too little soil moisture is also a source of stress. See RPD 604.
Sirococcus tip blight	None identified for homeowner use.	Spray when needles are half-grown (as soon as bud caps fall off) and again when fully elongated. This disease is not common. See RPD 624.
Sycamore, Planetree (<i>Plantanus</i>)		
Anthracnose (leaf-blight stage only)	Bonide Bonomyl, Bonide Fung-onil, Dragon 3336, Dragon Copper, Dragon Daconil, Ferti-lome Halt, Hi-Yield Bordeaux, Ortho Daconil, Phyton 27.	Spray 4 times: (1) just before buds break open, (2) at budbreak, (3) when leaves are expanded, and (4) 10 to 20 days later. Remove cankered twigs where feasible. Preventive fungicides may be injected by someone trained in injection. See RPDs 621, 648.
Other fungal leaf spots/blights		

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
<i>Taxus</i> —See Yew.		
<i>Thuja</i> —See Arborvitae.		
Tuliptree (<i>Liriodendron</i>)		
Anthracnose Other fungal leaf spots/blights	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications at budbreak. Follow label directions. See RPD 621.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears. Follow label directions.
Viburnum		
Fungal leaf spots	Bonide Bonomyl, Bonide Remedy, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt.	Begin applications when disease first appears.
Powdery mildew	Bonide Bonomyl, Bonide Fung-onil, Bonide Remedy, Dragon 3336, Dragon Daconil, Ferti-lome Halt, Immunox, Orthenex-1, Ortho Daconil.	Begin applications when disease first appears. See RPD 617.
Downy mildew	Dragon Mancozeb.	Disease is favored by damp conditions. Begin applications when disease first appears.
Virginia Creeper —See Ivy.		
Walnut, Butternut (<i>Juglans</i>)		
Anthracnose Other fungal leaf spots/blights	Bonide Bonomyl, Dragon 3336, Dragon Mancozeb, Ferti-lome Halt, Ferti-lome Systemic.	Spray 3 or 4 times, at labeled intervals, beginning when the leaves begin to unfold. See RPDs 600, 621.
Powdery mildew	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Immunox.	Begin applications when disease first appears. See RPD 617.
Bacterial blight (of Persian or English walnut)	Dragon Copper.	Spray 4 times: (1) at the start of flowering, (2) at full bloom, (3) at petal fall, and (4) 7 to 10 days later.
Willow (<i>Salix</i>)		
Tar spot Ink spot (leaf blight) Scab Black canker	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Make 2 or 3 applications, at labeled intervals, beginning when leaf buds begin to open. Rake and destroy fallen leaves.
Rust	Orthenex-1.	Begin applications, at labeled intervals, about 1 to 2 weeks before rust normally appears. See RPD 605.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 6. Products Labeled for Specific Woody Ornamentals (cont.)

Plant and disease	Labeled pesticides ^a	Comments ^a
Willow (<i>Salix</i>) (cont.)		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt, Ferti-lome Sulfur, Immunox, Orthenex-1.	Begin applications when disease first appears. See RPD 617.
Witchhazel (<i>Hamamelis</i>)		
Powdery mildew	Bonide Bonomyl, Bonide Liquid Sulfur, Dragon 3336, Ferti-lome Halt.	Begin applications when disease first appears. Follow label directions.
Fungal leaf spots	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt.	Begin applications as the leaves begin to unfold. Follow label directions.
Yew (<i>Taxus</i>)		
Twig blight (<i>Phomopsis</i>)	Bonide Bonomyl, Dragon 3336, Ferti-lome Halt, Hi-Yield Bordeaux.	Begin applications when new growth emerges.

^aRefer to Table 7 for additional product information. Before using any product, carefully read its label to identify any varietal, environmental, or plant-stage interactions that may occur. Repeated use of a product or active ingredient may lead to pesticide resistance and the loss of pest control. Whenever possible, alternate effective active ingredients to reduce the development of pest resistance. See the *Commercial Landscape and Turfgrass Pest Management Handbook* (updated annually) for additional products available to commercial applicators.

TABLE 7. Pesticides Listed in Tables 2, 4, and 6

Abbreviation	Full trade name and company information	Active ingredient(s)	Mobility ^a
Bonide Bonomyl	Bonide Bonomyl 50W	thiophanate-methyl	S
Bonide Captan	Bonide Captan 50W	captan	PC
Bonide Copper	Bonide Copper Dust	copper	PC
Bonide Fung-onil	Bonide Fung-onil	chlorothalonil	PC
Bonide Liquid Sulfur	Bonide Liquid Sulfur	sulfur	PC
Bonide Mancozeb	Bonide Mancozeb	mancozeb	PC
Bonide Remedy	Bonide Remedy	potassium bicarbonate	PC
Bonide Sulfur	Bonide Sulfur	sulfur	PC
Dragon 3336	Dragon Systemic Fungicide 3336 WP	thiophanate-methyl	S
Dragon Captan	Dragon Captan	captan	PC
Dragon Copper	Dragon Copper Fungicide	copper	PC
Dragon Daconil	Dragon Daconil 2787	chlorothalonil	PC
Dragon Mancozeb	Dragon Mancozeb	mancozeb	PC
Dragon Sulfur	Dragon Wettable or Dusting Sulfur	sulfur	PC
Ferti-lome Blackspot	Ferti-lome Blackspot	copper hydroxide	PC
Ferti-lome Fire Blight	Ferti-lome Fire Blight Spray	streptomycin sulfate	S
Ferti-lome Fruit Tree	Ferti-lome Fruit Tree Spray	captan + *malathion	PC/PC
Ferti-lome Fungicide	Ferti-lome Liquid Fungicide	chlorothalonil	PC
Ferti-lome Halt	Ferti-lome Halt	thiophanate-methyl	S
Ferti-lome Insecticide & Fungicide	Ferti-lome Azalea, Camellia, Crape Myrtle Insecticide & Fungicide	*malathion + PCNB	PC/PC
Ferti-lome Rose Spray	Ferti-lome Rose Spray	chlorothalonil + *diazinon	PC/PC
Ferti-lome Sulfur	Ferti-lome Dusting Sulfur	sulfur	PC
Ferti-lome Systemic	Ferti-lome Systemic Fungicide	propiconazole	S
Ferti-lome Triple	Ferti-lome Triple Action	chlorothalonil + *diazinon	PC/PC
Funginex	RosePride Funginex Rose & Shrub Disease Control	triforine	S
Hi-Yield Bordeaux	Hi-Yield Bordeaux Mix	copper sulfate	PC
Hi-Yield Lime Sulfur	Hi-Yield Lime Sulfur	calcium polysulfides	PC
Hi-Yield Maneb	Hi-Yield Maneb Garden Fungicide	maneb	PC
Immunox	Spectracide Immunox	myclobutanil	S
Immunox Plus	Spectracide Immunox Plus	myclobutanil + *permethrin	S/PC
Orthenex	RosePride Orthenex Rose & Shrub Disease Control (Ortho/Scotts)	triforine + *acephate + *fenbutatin-oxide	S/PC/PC
Orthenex-1	RosePride Orthenex Rose & Shrub Disease Control-1 (Ortho/Scotts)	triforine + *acephate + *resmethrin	S/PC/PC
Ortho Daconil	Ortho Multi-Purpose Fungicide Daconil 2787 (Ortho/Scotts)	chlorothalonil	PC
Ortho Home Orchard	Ortho Home Orchard Spray (Ortho/Scotts)	captan + *malathion + *methoxychlor	PC/PC/PC
Ortho Lime-Sulfur	Ortho Dormant Disease Control Lime-Sulfur Spray (Ortho/Scotts)	calcium polysulfides	PC
Phyton 27	Phyton 27 (Source Technologies)	copper sulfate pentahydrate	PC

^aPesticide mobility: PC = protective-contact, S = systemic (translocated). Note: The systemic pesticides listed above do not move downward in the plant when applied to the foliage. However, several of them can be drenched into the root zone to protect the root system. Read and follow the label carefully.

*Active ingredients marked with an asterisk are insecticides and/or miticides.



CHAPTER 5



MANAGING DISEASES IN THE HOME VEGETABLE GARDEN

Diseases of vegetables grown in the home garden may reduce both the yield and the quality of vegetables. Controlling such diseases often determines success or failure and adds immeasurably to the pleasure derived from a garden.

Diseases of vegetables are caused by microorganisms, including fungi, bacteria (including mycoplasmas and spiroplasmas), viruses, and nematodes. These organisms are spread by windblown or water-splashed spores, by insects, by infected seeds and transplants, by the movement of infested soil, and by humans handling wet plants.

Many vegetable diseases can be controlled using an integrated disease-control program. Such a program involves the use of

- crop rotation
- sanitation
- disease-resistant or -tolerant varieties
- disease-free seeds or transplants
- sound horticultural practices
- balanced soil fertility (based on soil tests)
- proper and timely application of pesticides.

No single pest-management practice can control all diseases of any vegetable crop. Therefore, several measures must be used to achieve satisfactory control.

Disease Control Before Planting

Choose and Prepare the Site

The site for the vegetable garden should be well drained and have adequate sunlight (8 to 10 hours of direct sunshine per day) and good air circulation. The soil should have adequate soil fertility and the proper pH (5.5 to 7.0).

If garden vegetables have been produced for several years in an area, sanitation and rotation practices can reduce the risk of disease-causing organisms that survive from

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.

preceding crops. It is important for disease-control purposes to remove or bury dead and diseased plant material in the fall. Crop residues from healthy plants can be composted and returned to the garden.

Disease-causing fungi and bacteria can survive composting unless the decomposition of the crop residue is *complete*, a situation that seldom occurs. Therefore, we suggest that no diseased plant parts be placed in the compost pile. Some disease organisms survive even complete composting, including pathogens causing corn smut; clubroot of cabbage, broccoli, cauliflower, and other crucifers; *Verticillium* wilt of potato, tomato, pepper, and eggplant; and root-knot.

Turning under (plowing or tilling) crop residues in the fall helps prevent the overwintering of many disease-causing organisms. Besides destroying the "winter home" of various organisms, this practice also helps control the insects that transmit certain diseases. Also, crop debris that is turned under improves soil tilth and makes spring garden work easier.



Cabbage

Rotate Crops

Crop rotation is an important control measure because many disease-causing organisms attack only related plants in the same family. Unrelated plants do not serve as hosts on which these organisms can multiply. Therefore, if possible, avoid planting any vegetables *within* each of the following groups in the same location more than once every 3 or 4 years.

- **Cole crops** (cabbage family)—broccoli, brussels sprout, cabbage, cauliflower, chinese cabbage, kohlrabi, mustard greens, radish, rutabaga, and turnip.
- **Cucurbits** (cucumber family)—cucumber, gourd, muskmelon, pumpkin, squash (all types), and watermelon.
- **Solanaceous crops** (tomato family)—eggplant, husk tomato (ground cherry), pepper, potato, and tomato.
- **Chenopodiaceous crops**—beet (red and sugar) and spinach.
- **Amaryllidaceae** (onion family)—chives, garlic, leek, onion, and shallot.
- **Legumes**—beans (all types) and peas.
- **Umbelliferous crops**—carrots, celery, and parsnip.

For example, broccoli, cabbage, radish, or turnip should not be planted in the same location for two successive years. Cabbage could be followed with beans, a vine crop such as cucumber, or sweet corn.

Diseases affecting beans, peas, sweet corn, carrot, lettuce, spinach, rhubarb, okra, edible soybeans, and similar plants are usually specific to only one of these crops and generally do not infect others or members of the major vegetable crop groups.

Choose Disease-Resistant Varieties

The use of well-adapted, disease-resistant varieties is the simplest and most efficient method of controlling many diseases. Information on disease resistance is given in the following paragraphs. Listings of disease-resistant or -tolerant reactions for selected vegetable varieties, unless otherwise indicated, are based on the disease reactions reported by the various seed companies and have not necessarily been verified by independent research at the University of Illinois. Furthermore, a designation of resistance or tolerance does not necessarily mean that the plant is immune to the disease and shows no disease symptoms. Some varieties are partially resistant, and the expression of symptoms and development of the disease are reduced when compared to a susceptible variety. (See Tables 1 to 9.) Also, some forms of resistance are effective against only certain strains or races of the disease-causing agent. Thus, a variety described as being resistant to a particular disease can acquire that disease under certain circumstances.



Squash

Start with Disease-Free Seeds, Plants, and Planting Materials

It is important to start with disease-free seeds or planting materials (bulbs, tubers, transplants, sets, etc.) to keep from introducing serious diseases into the garden. In general, gardeners are encouraged *not* to save their own seed but to purchase seed from reputable seed dealers. Hot-water soaks and fungicide seed treatments may be used to control the seedborne disease organisms that cause damping-off and seed rots. Because temperature controls and timing must be precise, home gardeners usually buy seed that has already been treated with hot water by the seed producer. Hot-water treatment of cabbage, broccoli, brussels sprout, and cauliflower seed is particularly important. More information on hot-water and fungicide seed treatments may be found in *Report on Plant Disease* 915, "Vegetable Seed Treatment," available from the Department of Crop Sciences, N-533 Turner Hall, 1102 S. Goodwin Ave., Urbana, IL 61801.

Many vegetable seeds are coated with a fungicide, as evidenced by the colored coating on the seed. Untreated seed can be treated by the home gardener by placing a small quantity (the size of one or two match heads) of captan or thiram in the seed packet and shaking the packet for a minute or two to cover the seed thoroughly. Excess protectant may be sifted out before planting the seed.

Do not plant diseased material (for example, transplants, sets, bulbs, or tubers). All planting material should be healthy and free of yellowing and brown or black spots, and it should not be stunted or show poor development. Only certified, disease-free potato tubers or sweet potato slips should be used. Examine transplants thoroughly for signs of leaf or stem disease. It never pays to buy and plant diseased transplants, no matter what the price!

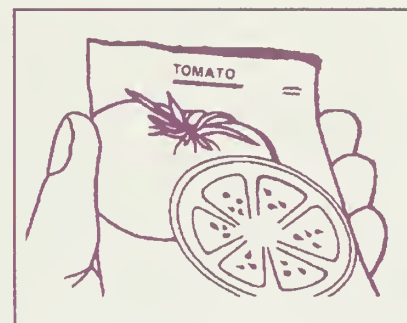
Damping-off diseases affecting homegrown vegetable transplants can be controlled by the use of pathogen-free soil and fungicides. Specific recommendations are given in *Report on Plant Disease* 916, "Damping-off Diseases of Vegetables," available from the Department of Crop Sciences, N-533 Turner Hall, 1102 S. Goodwin Ave., Urbana, IL 61801.

Cultural Practices

Cultural practices—such as controlling weeds, planting at the right time, planting at the proper depth and spacing, employing cages or stakes, and watering when the temperature is rising to promote a rapid drying of the foliage—can help control many foliar diseases. Mulches help to control fruit rots and aid in control of blossom-end rot of tomato, pepper, and vine crops by maintaining a uniform supply of moisture in the soil. Weed control in and around the garden reduces the risk of attacks by viruses that overwinter in these plants. Do not work or harvest wet plants because this can spread many diseases, particularly those caused by bacterial and fungal pathogens.

Disease Control During the Growing Season

Many diseases, such as the early blight disease of potato and tomato, occur each year despite all preplanting precautions. For such diseases, applications of fungicides and bactericides to the growing plants may be needed. The best way to apply these materials is as sprays *before* the disease occurs. Often a wetting agent such as liquid detergent or soap ($\frac{1}{2}$ teaspoon in 1 gallon of the fungicide solution) is added to obtain a more thorough wetting and coverage of the foliage. Apply sprays to the point of runoff, on a 7- to 10-day schedule. This schedule maintains a fresh or effective covering of fungicide and protects the new growth. Fungicides and bactericides currently recommended for use on vegetables are listed in Table 10.



Use disease-free seed.

Principal Diseases of Vegetables and Recommended Control Measures

Asparagus

Crown and root rots

Maintain proper fertility and good soil drainage. Avoid overcutting. The hybrid varieties listed as rust resistant have some resistance to *Fusarium* crown and root rot.

Rust

Grow resistant varieties (Martha Washington, Mary Washington, Viking, Waltham Washington, or hybrids, including Greenwich, Jersey Centennial, and Jersey Giant). Start spray applications after harvest, and continue until mid-August on a 7- to 10-day schedule with an approved fungicide.

Beans

Seed decay and damping-off

Plant disease-free certified seed. Use captan- or thiram-treated seed. Plant in a warm, moist, well-prepared seedbed.

Anthracnose

Follow a 2- or 3-year crop rotation. Practice strict sanitation. Apply an appropriate fungicide.

Bacterial blights

Practice a 2- or 3-year crop rotation. Do not save seed from infected plants. Purchase seed from a reputable seed dealer. Spray a copper-based bactericide such as Kocide or copper sulfate at the first sign of disease, and continue on a 7-day schedule until harvest. Do not work among wet plants.

Rust

Grow rust-resistant varieties (Dade, Kentucky Wonder Rust Resistant). Apply fungicides at the first sign of disease, and continue on a 7-day schedule.

White mold

Avoid wet locations with a history of white mold. Apply an approved fungicide when 10 to 25% of the blossoms are open and again at full bloom.

Mosaics

Grow resistant varieties. Table 1 contains a list of disease-resistant bean varieties.

Beets

Seed decay and damping-off

Plant seed treated with thiram or captan.

Leaf spots

Practice a 2- or 3-year crop rotation. Spray with an approved fungicide on a 7-day schedule.

Carrots

Seed decay and damping-off

Plant seed treated with captan or thiram.

Leaf spots

Practice a 2- or 3-year crop rotation. Spray weekly with an approved fungicide, starting when disease first appears (about mid-June). Varieties resistant to *Cercospora* leaf spot include Danvers 126, Gold Pak, and Spartan Fancy.

Aster yellows

Destroy infected plants as soon as they appear. Apply insecticide sprays for leaf-hopper control. Spray before removing infected plants.

Cole Crops (cabbage, broccoli, brussels sprout, cauliflower, chinese cabbage, kohlrabi, mustard greens, radish, rutabaga, and turnip)

Seed decay, damping-off, black rot, and blackleg

Plant hot water-treated seed that also has been treated with captan or thiram. Several black rot-resistant cabbage varieties are now available. See Table 2.

Clubroot

Purchase disease-free transplants. PCNB (Terraclor) may be added to the transplant water.

Principal Diseases of Vegetables and Recommended Control Measures (cont.)

Cole Crops (cont.)

- | | |
|------------------------|---|
| Fusarium yellows | Grow only varieties that are resistant to yellows. Table 2 contains a list of cabbage varieties that are disease resistant. |
| Leaf spots and blights | Practice a 2- or 3-year crop rotation for broccoli, cabbage, cauliflower, and brussels sprout. Apply an approved fungicide on a 7-day schedule. |

Cucurbits (cucumber, gourds, muskmelon, pumpkin, squash, and watermelon)

- | | |
|--|--|
| Seed decay and damping-off | Plant seed treated with captan. Plant in a warm, well-prepared seedbed. Avoid excessive soil moisture. |
| Angular leafspot | Practice a 2- or 3-year crop rotation. Spray with a fixed-copper bactericide, such as Kocide 101 or copper sulfate. Remove diseased plant material. Plant resistant varieties whenever possible. |
| Anthracnose, Alternaria leaf blight, downy mildew, blossom blights, fruit rots and spots, and gummy stem blight or black rot | Practice a 2- or 3-year crop rotation. Apply an approved fungicide at weekly intervals, starting when the plants are in the 2-leaf stage. Adequate nitrogen fertility is essential for the successful control of Alternaria leaf blight. Plant resistant varieties when available. |
| Bacterial wilt | Spray with an insecticide to control cucumber beetles as soon as the seedlings "crack" the soil but before they emerge. Continue weekly spraying until the plants are in bloom. Spray in the evening to avoid killing bees. |
| Fusarium wilt | Grow only cantaloupe and watermelon varieties that are resistant to Fusarium wilt. Table 3 lists disease-resistant muskmelon (cantaloupe) varieties, and Table 4 lists disease-resistant watermelon varieties. |
| Powdery mildew | Spray with an approved fungicide at the first sign of disease, and continue to spray weekly thereafter. Grow resistant varieties. |
| Mosaic and other viral diseases | Grow resistant varieties when possible. Only cucumbers resistant to cucumber mosaic should be grown. Table 5 lists disease-resistant cucumber varieties. |

Eggplant

- | | |
|---|---|
| Seed decay, damping-off, and Phomopsis blight | Plant seed treated with captan or thiram. |
| Phomopsis blight and other fruit rots | Practice a 2- or 3-year crop rotation. Spray weekly with an approved fungicide when fruits are half size or when disease first appears. |
| Verticillium wilt | Mulching with plastic may help reduce losses. |

Lettuce, Endive, Escarole

- | | |
|---|---|
| Seed decay and damping-off | Plant seed treated with thiram or captan. Practice 2-year rotation. |
| Rhizoctonia bottom rot, Sclerotinia drop, and gray mold | Plant on raised beds. Remove diseased plant material after harvest. |
| Aster yellows and mosaic viruses | Control leafhoppers and aphids throughout the season; early season control is most important. |

TABLE 1. Disease-Resistant/-Tolerant Bean Varieties

Variety	Seed source ^a	Disease ^b							
		CBMV	NY15	NL8	PM	R	BBS	CTV	HB
Green snap beans									
Benchmark	NV, RG	x	x	x	—	—	—	x	—
Blue Lake 274	Many	x	x	—	—	—	—	—	—
Bronco	AS	x	—	—	—	—	—	—	—
Contender	RU	x	—	—	x	—	—	—	—
Daytona	FM, HM	x	—	—	—	x	—	—	—
Derby (AAS)	FM, HM	x	—	—	—	x	—	—	—
Endurance	NV, RG	x	x	x	—	—	x	x	—
Hialeah	FM, HM	x	—	—	—	—	—	—	—
Hystyle	HM	—	—	—	—	—	x	—	—
Jade	NV, RG	x	x	x	—	x	—	x	—
Mirada	NV, RG	x	x	x	—	—	—	x	—
Opus	AS	x	—	—	—	x	—	—	—
Provider	RS, ST, SW	x	x	—	x	—	—	—	—
Rhapsody	SW	x	—	—	—	x	—	—	—
Roma II	NV, RG	x	x	—	—	x	—	—	—
Rushmore	AS	x	—	—	—	—	—	—	—
Seville	NV, RG	x	x	—	—	—	—	—	—
Sonata	HM	x	—	—	—	—	—	—	—
Strike	AS	x	—	—	—	—	—	—	—
Tema	RS, RU, ST	x	—	—	—	—	—	—	—
Tendercrop	RU	x	—	—	—	—	—	—	—
Tenderette	RU	x	x	—	—	—	—	—	—
Pole snap beans									
Kentucky Blue	NV, RG	x	—	—	—	x	—	—	—
White Half Runner	SI	x	—	—	—	—	—	—	—
Yellow wax beans									
Cherokee	RS, RU	x	x	—	—	—	—	—	—
Eureka	RS, RU	x	—	—	—	—	—	—	—
Gold Crop	Many	x	—	—	—	—	—	x	—
Gold Mine	AS	x	—	—	—	—	—	—	x
Gold Rush	AS	x	—	—	—	—	—	—	—
Goldkist	NV, RG	x	x	x	—	x	x	—	—
Nugget	HM	x	—	—	—	—	—	—	—

^aFor a key to seed sources, see page 122.^bDisease key: CBMV = common bean mosaic virus, NY15 = bean mosaic virus race NY15, NL8 = bean mosaic virus race NL8, PM = powdery mildew, R = rust, BBS = bacterial brown spot, CTV = curly top virus, and HB = halo blight.

TABLE 2. Disease-Resistant/-Tolerant Cabbage Varieties

Variety	Seed source ^a	Type	Disease ^b				
			BRT	FYR	TBT	ALT	BLT
Bronco	BE, SW	green fresh	x	x	x	—	—
Fresco	BE, SW	green fresh	x	x	x	—	—
Gideon	BE, SW	green fresh	x	x	x	—	—
Golden Acre	RU	green	x	—	—	—	—
Morris	BE, SW	green fresh	—	x	x	—	—
Ramada	BE, SW	green fresh	x	x	x	—	—
Stonehead	ST, RU	gray green	—	x	x	—	—
Atlantis	PS	blue green	x	x	—	—	—
Augusta	NV, RG	blue green	x	x	—	—	—
Blue Bayou	AS	blue green	x	x	—	—	—
Blue Gem	HM	blue green	x	x	—	—	—
Blue Pak	HM	blue	—	x	—	—	—
Blue Thunder	HM	blue green	x	x	x	—	—
Blue Vantage	SA	blue green	x	x	x	—	—
Bravo	HM	blue green	x	x	—	—	—
Charmont	LS	blue green	—	x	x	—	—
Cheers	AT	blue green	x	x	—	—	—
Conquest	RU	blue green	—	x	—	—	—
Dynamo (AAS)	NV, RG	mini blue green	—	x	—	—	—
Emblem	SA	blue green	x	x	x	—	—
Fortress	FM, HM	blue green	x	x	—	—	—
Grand Prize	RS	blue green	—	x	x	—	—
Green Boy	NV, RG	blue green	—	x	—	—	—
Green Cup	AT	blue green	x	x	—	—	—
Lynx	RS	blue green	x	x	x	—	—
Pacifica	SA	blue green	x	x	—	—	—
Quisto	NV, RG	blue green	x	x	x	—	—
Rio Verde	NV, RG, SA	blue green	—	x	—	—	—
Royal Vantage	SA	blue green	x	x	—	—	—
Supreme Vantage	SA	blue green	—	x	x	—	—
Sure Vantage	SA	blue green	x	x	x	—	—
Talisman	FM, HM	blue green	x	x	—	x	—
Tenacity	ST	blue green	x	—	—	—	—
Vantage Point	SA	dark blue green	x	x	x	—	—
Olympic	SI	silver blue	x	x	x	—	—
Pruktor	SI	silver blue	x	x	—	—	—
Azurro	BE, SW	red fresh	—	—	x	—	x
Red Dynasty	AS	red	x	x	x	—	—
Super Red 77	ST	red	x	x	x	—	—
Clarissa	BE, SW	green Savoy	—	x	x	—	—
Melissa	BE, SW	green Savoy	—	x	x	—	—
Speedy Savoy	ST	blue green Savoy	—	x	x	—	—

^aFor a key to seed sources, see page 122.^bDisease key: BRT = black rot tolerant, FYR = Fusarium yellows resistant, TBT = tip burn tolerant, ALT = Alternaria leaf spot, and BLT = black leg tolerant.

TABLE 3. Disease-Resistant/-Tolerant Muskmelon Varieties

Variety	Seed source ^a	Disease		
		Fusarium wilt	Powdery mildew	Downy mildew
Ambrosia	many	—	x	x
Eclipse	ST	x	x	—
Harper	RU	x	—	—
Legend	RS	x	x	—
Palsar	many	x	x	—
Saticoy	many	x	x	—
Star Fire	HM	x	x	x
Starship	HM	x	x	—

^aFor a key to seed sources, see page 122.**TABLE 4.** Disease-Resistant/-Tolerant Watermelon Varieties

Variety	Seed source ^a	Disease	
		Fusarium wilt	Anthrachnose
Allsweet	many	x	x
Carnival	NV, RG	x	x
Charleston Gray	many	x	x
Crimson Sweet	NV, RG	x	x
Crimson Tide	NV, RG	x	x
Emperor	PS, RU, ST	x	—
Fiesta	NV, RG	x	x
Jubilee	many	x	x
Regency	SW	x	—
Royal Jubilee	many	x	—
Royal Sweet	SI, SW	x	—
Sangria	NV, RG	x	x
Sultan	RS	x	x

^aFor a key to seed sources, see page 122.

TABLE 5. Disease-Resistant/-Tolerant Cucumber Varieties

Variety	Seed source ^a	Disease ^b								
		Scab	CMV	PM	DM	ANT	ALS	ZYMV	WMV	PRSV
Burpless slicers										
Burpless #26	RU	—	x	x	x	—	—	—	—	—
Orient Express	RS, RU, SW	x	x	x	x	x	—	—	x	—
Sweet Slice	RS, RU, ST	x	x	x	x	x	x	—	x	—
Slicers										
Dasher II	many	x	x	x	x	x	x	—	—	—
Daytona	SI, ST, SW	x	—	x	—	x	x	x	x	x
General Lee	many	x	x	x	x	—	—	—	—	—
Greensleeves	HM, RS	x	x	x	x	—	x	—	—	—
Indy	many	x	x	x	—	x	x	x	x	x
Jazzer	EZ, ST	x	x	x	x	—	—	—	—	—
Lightning	RU	x	x	x	—	—	—	x	—	—
Marketmore 76	many	x	x	x	x	—	—	—	—	—
Panther	SI, ST	x	x	x	x	x	x	—	—	—
Raider	HM, RS	x	x	—	—	—	x	—	—	—
Speedway	many	x	x	x	x	x	x	—	—	—
Thunder	RS, RU	x	x	x	—	—	—	x	—	—
Ultraslice	ST	x	x	x	x	x	x	—	—	—
Pickling										
Calypso	RS, RU	x	—	x	x	x	x	—	—	—
Carolina	RU	x	x	x	x	x	x	—	—	—
Eureka	many	x	x	x	x	x	x	—	x	x
Fancipak M	many	x	x	x	x	x	x	—	—	—

^aFor a key to seed sources, see page 122.^bDisease key: CMV = cucumber mosaic virus, PM = powdery mildew, DM = downy mildew, ANT = anthracnose, ALS = angular leaf spot, ZYMV = zucchini yellows mosaic virus, WMV = watermelon mosaic virus (WMV-2), and PRSV = papaya ring spot virus type W (WMV-1).**TABLE 6.** Disease-Resistant Pea Varieties

Variety	Seed source ^a	Disease ^b						
		FUS	BYMV	DM	PEV	CW	PM	PSV
Green Arrow	BP, HM, RU, ST SW	x	—	x	—	—	—	—
Knight	AC, HM, RU, SS	x	x	—	x	—	x	—
Lincoln	RU, SS, ST	x	—	—	—	—	—	—
Oregon Sugar Pod no. 2	AC, BP, HM, RU, SS, SW	x	—	—	x	—	x	x
Sugar Ann	AC, RU	—	—	—	—	x	—	—

^aFor a key to seed sources, see page 122.^bDisease Key: FUS = Fusarium, BYMV = beet yellow mosaic virus, DM = downy mildew, PEV = pea enation virus, CW = common wilt, PM = powdery mildew, and PSV = pea streak virus.

Principal Diseases of Vegetables and Recommended Control Measures (cont.)

Okra

Seed decay and damping-off Plant seeds treated with thiram or captan.

Fusarium and Verticillium wilts Practice 3- or 4-year rotation.

Onion

Seed decay, damping-off, and smut Plant seed treated with thiram or captan.

Bulb rots Control leaf diseases. Avoid storing improperly cured or injured bulbs. Let all onion tops fall over (ripen) naturally. Dry the bulbs before storage. Store under cool, dry conditions. Do not expose cured bulbs to sunscald, water, or high humidity.

Fusarium basal rot Grow resistant varieties. Alba Globe, Harvestmore, and Spartan Banner are resistant.

Leaf diseases Practice a 3- or 4-year crop rotation. Spray weekly with an approved fungicide. Carefully follow label directions regarding the days between the last spray and harvest.

Peas

Seed decay and damping-off Plant seed treated with captan or thiram.

Fusarium wilt Plant only varieties that are resistant to wilt. See Table 6 for a list of disease-resistant varieties.

Root rot Plant early in well-drained soils. Use a fungicide seed treatment. Practice at least 4-year rotation if problem continues.

Peppers

Seed decay and damping-off Plant seed treated with captan or thiram.

Bacterial spot Plant disease-free seed and/or transplants. Use the hot-water seed treatment; or dip seed in a solution of 1 part household bleach to 3 parts water, soak 1 minute, and rinse with water. Follow with a fungicide seed treatment. Apply weekly sprays of a fixed-copper fungicide, such as Kocide 101 or copper sulfate, through the bloom stage. Rotate to crops outside the tomato family.

Leafspot and fruit spot Use disease-free seed. Practice 3-year rotation. Remove diseased plant material after harvest. Apply an approved fungicide at 7- to 10-day intervals.

Phytophthora blight Avoid planting in low, water-logged areas. Plant on hills or raised beds. Plant resistant varieties whenever available. Do not overwater.

Tobacco mosaic Plant resistant varieties whenever available. See Table 7 for a list of these varieties.

Potato

Seed-piece rots Treat cut seed pieces with captan as a dust or dip. Plant in warm soil (over 50°F) after the cut surfaces have corked over (suberized).

TABLE 7. Disease-Resistant/-Tolerant Pepper Varieties

Variety	Seed source ^a	Disease ^b							
		PVY	BLS			TEV	TMV	CMV	PHY
			(R1,	R2,	R3)				
Green-yellow bell									
Admiral	RG	x	x	x	—	—	x	—	—
Early Sunsation	PS	x	x	x	x	—	x	—	—
Gold Coast	AS	—	x	x	x	—	x	—	—
X3R Aladdin	PS	—	x	x	x	—	x	—	—
Green/red sweet									
Boynton Bell	HM	—	x	x	x	—	—	—	—
Brigadier	NV, RG	x	x	x	x	—	—	—	—
Commandant	NV, RG	x	x	x	x	—	x	—	—
Emerald Isle	HM	x	—	—	—	—	—	x	x
Enterprise	AS	x	x	x	x	—	x	—	—
Guardian	RG	x	x	x	—	x	x	—	—
Karma	HM	—	—	—	—	—	x	—	—
King Arthur	PS	x	—	x	—	x	x	—	—
Lantern	JS	—	—	—	—	—	x	—	—
Marquis	SW	x	—	—	—	x	—	—	—
Paladin	NV, RG	—	—	—	—	—	x	—	x
PS334094	PS	—	x	x	x	—	—	—	—
Sentinel	RG	x	x	x	—	—	x	—	—
Sentry	RG	x	x	x	x	—	—	—	—
Vivaldi	VL	—	—	—	—	—	x	—	—
X3R Camelot	PS	—	x	x	x	—	x	—	—
X3R Wizard	PS	—	x	x	x	—	x	—	—
Yorktown	AS	—	x	x	x	—	—	—	—
Sweet banana									
RPP4277-F1	RG	—	x	x	x	—	—	—	—

^aFor a key to seed sources, see page 122.^bDisease key: PVY = potato virus Y, BLS = bacterial leaf spot (Races 1, 2, 3), TEV = tobacco etch virus, TMV = tobacco mosaic virus, CMV = cucumber mosaic virus, and PHY = Phytophthora root rot.

Principal Diseases of Vegetables and Recommended Control Measures (cont.)

Potato (cont.)

Early blight and late blight

Practice a 2- or 3-year crop rotation. Destroy or remove cull tubers. Spray at weekly intervals, starting when the plants are 4 to 6 inches tall, with an approved fungicide. Plant varieties resistant to late blight.

Rhizoctonia canker

Practice at least 3-year rotation. Plant uncontaminated seed tubers.

Scab

Plant resistant varieties, or adjust the soil pH to 5.2 to 5.5. Use fungicide seed-piece treatments. Good scab-resistant red potato varieties are Norchief and Norland. Good scab-resistant white potato varieties are Norgold Russet and Superior.

Verticillium wilt and root-knot nematodes

Plant certified disease-free seed tubers. Plant resistant varieties.

Viruses and ring rot

Plant only "certified" disease-free seed tubers.

Storage rots

Store only disease-free, unbruised tubers. Allow tubers to cure at 60°F for 5 to 7 days before reducing the temperature to 36° to 40°F (if possible).

Spinach

Seed decay and damping-off

Plant seed treated with captan or thiram.

Downy mildew

Plant resistant varieties.

Cucumber mosaic virus

Plant resistant or tolerant varieties.

The variety Melody has resistance to both cucumber mosaic virus and downy mildew.

Sweet Corn

Seed decay and damping-off

Plant seed treated with captan or thiram.

Foliage blights and rust

Plant varieties resistant to northern and southern corn leaf blights and rusts. Apply an approved fungicide. However, the use of fungicides is rarely justified. Diseased plant material should be removed from the garden. Blighted leaf tissue is safe to compost.

Smut

Plant resistant varieties. Remove smut galls from the garden before they break. Do not compost smutted corn or infected corn residues.

Stewart's bacterial wilt

Plant resistant varieties. (See Table 8 for a list of varieties resistant to this and other diseases.) Control flea beetles with a recommended insecticide. Early season control is particularly important.

Maize dwarf mosaic

Plant as far from johnsongrass as possible. Control wild johnsongrass plants. Plant tolerant varieties.

Sweet Potato

Black rot, scurf, foot rot, and wilt

Buy certified, disease-free slips. Plant resistant varieties. Use a 3- or 4-year rotation. The varieties Allgold and Centennial have good resistance to wilt. Allgold also has resistance to black rot.

Storage diseases

Do not expose roots to temperatures below 55°F. Immediately after digging, cure the roots at 85°F and high humidity for 10 to 14 days. Store at 55°F. Never store in airtight bags or containers. Apply an approved fungicide as a postharvest dip. Follow the manufacturer's directions carefully.

Principal Diseases of Vegetables and Recommended Control Measures (cont.)

Tomato

Seed decay, damping-off, and seedborne diseases	Plant seed that has been treated with hot water or household bleach and that has been treated with captan or thiram. See treatments for pepper seed.
Bacterial speck, spot, and canker	Plant certified, disease-free seed or transplants. Practice a 3- or 4-year crop rotation. Spray plants weekly with a fixed-copper fungicide, beginning with the first sign of disease, through the bloom stage.
Blossom-end rot	Maintain uniform soil moisture by mulching the plants and irrigating when needed. Avoid heavy pruning, excessive nitrogen applications, and damage to the roots by cultivation or hoeing.
Early blight, Septoria leaf blight, anthracnose, buckeye rot, gray mold, and white mold (Sclerotinia)	Practice a 2- or 3-year crop rotation. Remove or destroy infected plant parts. Spray weekly with an approved fungicide. Carefully follow label directions regarding the days between the last spray and harvest. Staking or caging plants and providing good air circulation helps reduce foliar diseases. Staking, caging, or mulching also helps prevent fruit rots, such as anthracnose and buckeye rot. Varieties such as Floramerica, Jetstar, Manlucie, Roma VF, and Supersonic have some tolerance to the early blight disease.
Verticillium and Fusarium wilts	Grow only VF- or VFN-resistant varieties. Many varieties are available. Avoid soil with a history of wilt.
Root-knot nematodes	Grow VFN-resistant varieties.
Viruses	Avoid contact between potatoes and tomatoes to prevent "double infections" of potato and tomato viruses. Wash hands thoroughly with soap and hot water before handling your plants. Do not use tobacco when working with tomatoes.

TABLE 8. Disease-Resistant Sweet Corn Varieties

Variety ^a	Seed source ^b	Color ^c	Disease ^d					
			SW	CS	CR	NCLB	SCLB	MDM
Standard Sugary (SU)								
Comet	AS	W	x	—	x	x	—	—
Gold Cup	HM	Y	x	—	x	—	—	—
Honey 'n Frost	SW	B	x	x	x	x	x	—
Jubilee	RG, SW	Y	—	x	x	—	—	—
Seneca Horizon	HM, RU, ST, SW	Y	—	—	x	—	—	—
Silver Chief	AS	W	x	—	—	x	—	—
Silver Queen	AC, BP, HM, RU, ST, SW	W	x	—	—	x	—	—
Spring Dance	ST	Y	—	—	—	x	—	—
Stylepak	FM, ST	Y	x	—	—	—	—	—
Sugar Loaf	SS	Y	x	—	x	x	—	—
Sundance	HM, ST	Y	—	—	—	—	—	x
Sweet Sue	HM	B	x	—	—	—	—	—
Sugar Enhancer (SE)								
Calico Belle	AS	B	x	—	x	—	—	—
Classic	AS	Y	x	x	x	x	x	—
Esteem	HM	Y	—	—	x	—	—	x
Incredible	HM, RU, SW	Y	x	x	x	—	—	—
Miracle	AC, BP, RU, ST	Y	x	x	x	x	—	—
Platinum Lady	BP, RU, ST	W	—	x	x	—	—	—
Sugar Buns	RU, ST, SW	Y	—	—	x	x	—	—
Tuxedo	CR	Y	x	x	x	x	x	—
Super Sweet (SH2)								
Challenger	AS	Y	x	—	—	x	—	—
Florida Staysweet	Many	Y	x	—	—	x	x	—
How Sweet It Is	AC, BP, RU	W	x	—	—	x	—	—
Phenomenal	RU, ST, SW	B	—	x	—	x	x	—
Super Sweet 7710	AC	Y	x	—	—	x	x	—
Supersweet Jubilee	RS	Y	—	x	—	—	—	—
Sweet Belle	AS	Y	x	x	—	x	—	—
Sweetie 82	SW	Y	x	x	x	—	x	—

^aDisease reactions are based on evaluations at the University of Illinois and other universities.^bFor a key to seed sources, see page 122.^cColor key: W = white, Y = yellow, B = bi-color.^dDisease key: SW = Stewart's wilt, CS = common smut, CR = common rust, NCLB = northern corn leaf blight, SCLB = southern corn leaf blight, and MDM = maize dwarf mosaic.

TABLE 9. Disease-Resistant/-Tolerant Tomato Varieties

Variety	Seed source ^a	Disease ^b										
		VW	FW			TMV	GLS	BS	LB	EB	BER	Crack
			(R1,	R2,	R3)							
Aztec	PS	x	x	—	—	—	—	x	—	—	—	—
Basket Vee	ST	x	—	—	—	—	—	—	—	—	x	x
Captiva	PS	x	x	x	x	—	x	—	—	—	—	—
Celebrity	AS	x	x	x	—	x	x	—	—	—	—	—
Cherry Express	ST	x	—	—	—	x	—	—	—	—	—	x
Empereador	PS	x	—	x	—	—	—	—	—	—	—	—
Fabulous	SW	x	x	x	—	x	x	—	—	—	—	—
Floralina (NCS)	RU, SW	x	x	x	x	—	—	—	—	—	—	—
Florida 47	AS	x	x	x	—	—	x	—	—	—	—	—
Harvestvee	ST	x	x	—	—	—	—	—	—	—	—	—
Hy-beef 9904	ST	x	x	—	—	x	—	—	—	—	—	x
Merced	NV, RG	x	x	x	—	x	x	—	—	—	—	—
Mt. Belle	NV, RG	x	x	—	—	—	—	—	—	—	—	—
Mt. Fresh	HM	x	x	x	—	—	—	—	—	x	x	x
Mt. Gold	NV, RG	x	x	x	—	—	—	—	—	—	—	x
Mt. Spring	NV, RG	x	x	x	—	—	—	—	—	—	x	x
Plum Dandy	HM	x	x	—	—	—	—	—	—	x	—	x
Puebla	PS	x	x	x	—	—	x	x	—	—	—	—
Redrider	AS	x	x	x	—	—	x	—	—	—	—	—
Redstone	ST	x	x	—	—	—	—	—	—	—	—	—
Roadside Red	ST	x	x	—	—	—	—	—	—	—	—	—
Royal Mountie	SW	x	x	x	—	—	—	—	—	—	—	x
Sanibel	PS	x	x	x	—	—	x	—	—	—	—	—
Scarlet Express	ST	x	x	—	—	—	—	—	—	—	—	—
Seedway 10250	SW	x	x	x	—	—	x	—	—	—	—	—
Springfield	HM	x	x	x	—	x	x	—	—	—	—	—
Sun Leaper	NV, RG	x	x	x	—	—	—	—	—	—	—	—
Sunbeam	AS	x	x	x	—	—	x	—	—	—	—	—
Sunbrite	AS	x	x	x	—	—	x	—	—	—	—	x
Sungem	AS	x	x	x	—	—	x	—	—	—	—	x
Sunpride	RU	x	x	x	—	—	x	—	—	—	—	—
Sunrise	AS	x	x	x	—	—	x	—	—	—	—	—
Sunstart	AS	x	x	x	—	—	x	—	—	—	—	—
Supra	NV, RG	x	x	x	—	—	—	x	—	—	—	—
Sweet Gold	ST	—	x	—	—	x	—	—	—	—	—	x
Sweet Million	ST	—	x	—	—	x	—	—	—	—	—	x
Swiftly Belle	ST	x	—	—	—	x	—	—	—	—	—	x
Ultra Sweet	ST	x	x	—	—	x	—	—	—	—	—	x
UltraMagnum	ST	x	x	—	—	x	—	—	x	—	—	x
Ultrasonic	ST	x	x	—	—	x	—	—	—	—	—	x

^aFor a key to seed source, see page 122.^bDisease key: VW = Verticillium wilt, FW = Fusarium wilt (Races 1, 2, 3), TMV = tobacco mosaic virus, GLS = gray leaf spot (*Stemphylium*), BS = bacterial speck, LB = late blight, EB = early blight, BER = blossom-end rot, and Crack = crack tolerance.

TABLE 10. Fungicides for Use by Vegetable Gardeners

Crop	benomyl ^a	chlorothalonil ^b	copper ^c	maneb	mancozeb ^d	sulfur
Asparagus						
Rust	—	—	—	—	x	x
Bean						
Anthrachnose	—	x	—	—	—	—
Bacterial blights	—	—	x	—	—	—
Gray mold	—	x	—	—	—	—
Rust	—	x	—	—	—	x
White mold	x	—	—	—	—	—
Broccoli, cabbage, cauliflower						
Alternaria leaf spot	—	x	x	x	—	—
Black rot	—	—	x	—	—	—
Downy mildew	—	x	x	x	—	—
Carrots						
Alternaria leaf spot	—	x	—	—	—	—
Cercospora leaf spot	—	x	x	—	—	—
White mold	x	—	—	—	—	—
Cucumber, melons, pumpkin, squash						
Alternaria leaf spot	—	x	—	x	x ^e	—
Angular leaf spot	—	—	x	—	—	—
Anthrachnose	x	x	—	x	x ^e	—
Downy mildew	—	x	x	x	x ^e	—
Gummy stem blight	x	x	—	x	x ^e	—
Powdery mildew	x	x	x	—	—	x
Onion						
Botrytis blast	—	x	—	x	x	—
Downy mildew	—	x	x	x	x	—
Purple leaf blotch	—	x	x	x	x	—
Pepper						
Alternaria leaf spot	—	—	—	x	—	—
Anthrachnose	—	—	—	x	—	—
Bacterial spot	—	—	x	—	—	—
Phytophthora blight	—	—	—	x	—	—

Note: Fungicides registered for control of specific diseases are indicated by an x. Label registrations can change at any time. Therefore, these recommendations may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions.

^aThe fungicide benomyl is sold as Benlate.

^bThe fungicide chlorothalonil is sold as Bravo, Terranil, and several other names.

^cThere are many copper-based fungicides available, including bordeaux mixture, copper sulfate, copper hydroxide, and copper oxychloride sulfate, which are sold under a variety of trade names.

^dThe fungicide mancozeb is sold as Dithane and pencozeb.

^eFollow label directions for each cucurbit crop carefully; mancozeb is not registered for use on pumpkins.

TABLE 10. Fungicides for Use by Vegetable Gardeners (cont.)

Crop	benomyl ^a	chlorothalonil ^b	copper ^c	maneb	mancozeb ^d	sulfur
Potato						
Early blight	—	x	x	x	x	—
Late blight	—	x	x	x	x	—
Sweet corn						
Northern leaf blight	—	x	—	x	x	—
Rust	—	x	—	x	x	—
Tomato						
Anthracnose	—	x	x	x	x	—
Bacterial speck	—	—	x	—	—	—
Bacterial spot	—	—	x	—	—	—
Early blight	—	x	x	x	x	—
Gray leaf spot	x	x	—	x	x	—
Late blight	—	x	x	x	x	—
Septoria leaf spot	—	x	x	x	x	—
Sclerotinia stem rot	x	—	—	—	—	—

Note: Fungicides registered for control of specific diseases are indicated by an x. Label registrations can change at any time. Therefore, these recommendations may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions.

^aThe fungicide benomyl is sold as Benlate.

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^cThere are many copper-based fungicides available, including bordeaux mixture, copper sulfate, copper hydroxide, and copper oxychloride sulfate, which are sold under a variety of trade names.

^dThe fungicide mancozeb is sold as Dithane and pencozeb.

^eFollow label directions for each cucurbit crop carefully; mancozeb is not registered for use on pumpkins.

Key to Seed Sources

AC	Abbott & Cobb, Inc., Box 307, Feasterville, PA 19053-0307; (800)345-7333
AS	Asgrow Seed Co., 556 Armour St., Tifton, GA 31794; (800)234-1056
AT	American Takii Inc., 301 Natividad Rd., Salinas, CA 93906
BE	Bejo Zaden B.V., 1722 ZG Noordscharwoude, P.O. Box 9, Holland
BP	Burpee Vegetables/Ball Seed Co., 622 Town Rd., W. Chicago, IL 60185-2698; (708)231-3500
CR	Crookham Co., Box 520, Caldwell, ID 93605
DA	Daehnfeltdt Inc., Box 947, Albany, OR 97321
EZ	ENZA Zaden, Box 7, 1600 AA, Enkuisen, Netherlands 02280-15844
FM	Ferry-Morse Seed Co., Box 4938, Modesto, CA 95352; (209)579-7333
HM	Harris Moran Seed Co., 3670 Buffalo Rd., Rochester, NY 14624; (800)320-4672
JS	Johnny's Selected Seeds, Foss Hill Rd., Albion, MA 04910-9731; (207)437-4395
LS	Liberty Seed, Box 806, New Philadelphia, OH 44663
NV	Novartis Seeds, Inc., Vegetables-Rogers Brand, Box 4188, Boise, ID 83711-4188; (208)327-7272
PS	Petoseed Co., Inc., Box 4206, Saticoy, CA 94005; (800)647-7386
RG	Rogers Seed Co., Box 4188, Boise, ID 83711-4188; (208)322-7272
RS	Rispens Seeds, Inc., 3332 Ridge Rd., Box 5, Lansing, IL 60438; (888)874-0241
RU	Rupp Seeds, Inc., 17919 Co. Rd. B, Wauseon, OH 43567; (419)337-1841
SA	Sakata Seed America, Inc., Box 880, Morgan Hill, CA 95038; (408)778-7758
SI	Siegers Seed Co., 8265 Felch St., Zeeland, MI 49464-9503; (800)962-4999
SS	Sunseeds, 18640 Sutter Blvd., P.O. Box 2078, Morgan Hill, CA 95038
ST	Stokes Seeds, Inc., 737 Main St., Box 548, Buffalo, NY 14240; (800)396-9238
SW	Seedway, Inc., 1225 Zeager Rd., Elizabethtown, PA 17022; (800)952-7333
VL	Vilmorin Inc., P.O. Box 707, Empire, CA 95319; (209)529-6000

Information in Tables 1, 2, 3, 4, 5, 7, and 9 was adapted from "Disease Resistance Listing for Vegetable Crops" prepared by Loretta Ortiz-Ribbing. For up-to-date information on disease-resistant/-tolerant vegetable varieties, consult seed catalogs and/or seed dealers.

Author

M. Babadoost

Department of Crop Sciences



CHAPTER 6



MANAGING PESTS IN HOME FRUIT PLANTINGS

Pest management is necessary to grow top-quality fruit. Diseases, insects, mites, birds, and rodents attack all types of fruits grown in home plantings.

Proper planting, pruning, fertilizing, and fruit-thinning are important pest-control practices. Check with your local Extension office or the University of Illinois, ACES/ITCS Marketing and Distribution, 1917 S. Wright St., Champaign, IL 61820, or (800)345-6087 for publications on these topics.

Production Tips

Prune fruit trees annually to keep them short and open. Well-pruned trees are less susceptible to several diseases, are easier to spray, and dry more quickly. Destroy all prunings, particularly dead and diseased branches. Keep the grass under and around trees mowed to reduce mouse damage to trunks. Pick up and destroy fallen fruit. In autumn, collect all fallen leaves and fruit. Then burn, compost, or bury them. The spray schedules that follow include specific production recommendations for each fruit crop (Tables 2 to 7).

Disease-Resistant Apple Trees

Apple trees vary greatly in their susceptibility to various apple diseases. Researchers and apple breeders have developed apple cultivars with disease resistance to apple scab, powdery mildew, cedar apple rust, and fire blight. Homeowners can greatly reduce the number of sprays necessary to produce quality apples by planting disease-resistant trees. Red Delicious (with its bud sports), Golden Delicious, McIntosh, Jonathan, and Winesap are very susceptible. Prima, Priscilla, Jonafree, Freedom, Liberty, Dayton, Williams' Pride, GoldRush, Enterprise, Macfree, Redfree, and Pristine are new apple varieties that are highly resistant or immune to the scab fungus. We strongly recommend that home fruit growers plant these disease-resistant cultivars.

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.

Insecticides and Fungicides

The two most common types of pesticides used on fruit crops are insecticides and fungicides. Insecticides are designed to kill insects; and fungicides control diseases such as apple scab, powdery mildew, and fruit rots caused by fungi.

Multipurpose Fruit Sprays (MPFS)

Most garden centers sell multipurpose fruit sprays (MPFS), sometimes called orchard sprays (sold as Fruit Guard, Fruit Tree Spray, Home Orchard Spray, etc.), which contain two insecticides, usually methoxychlor and malathion, and a fungicide, usually captan. Methoxychlor is most effective against insects with chewing mouthparts, and malathion works best against insects with sucking mouthparts. Captan is a broad-spectrum protectant fungicide that controls several diseases if applied *before* the disease becomes established. If you have only a small area to spray (such as one or two trees, a few bushes, or a small patch of strawberries), the multipurpose fruit spray is the most convenient method of controlling pest problems.

For home fruit growers with more than a few trees or bushes or with a large strawberry patch, it might be preferable to buy the individual pesticides rather than the premixed multipurpose fruit spray. There are several reasons for this. First, there may be times when you want to spray a fungicide and not an insecticide, or vice versa. As an example, you should not apply insecticides during the bloom period because they kill the bees that are pollinating the flowers. You may need to apply a fungicide during that time. If your only fungicide has two insecticides mixed with it, you cannot apply the fungicide and may have disease problems as a result. Second, the insecticides included in the MPFS are not the best insecticides available. The best general-purpose insecticide for most fruit protection is phosmet (Imidan). For specific problems, carbaryl (Sevin), malathion, or diazinon may also be used, but methoxychlor would rarely be recommended. Finally, purchasing a premixed fruit spray is much more expensive than buying the fungicide and insecticide separately and mixing them as you need them. However, the individual pesticides may be difficult to find, and you may have to buy a larger container (5 pounds) than you would prefer.

Insecticides Considered to Be Organic

“Organic” insecticides generally are of natural origin, often derived from plants or used as naturally occurring compounds. They are, nonetheless, chemicals, and they are toxic to some degree to humans and pets. Handle them with care, and follow all label directions. Most organic insecticides are more expensive and less effective than their synthetic counterparts.

Rotenone is derived from tropical plants in the legume family. It is a stomach poison, so insects must eat spray residues on plant surfaces. It remains somewhat effective 3 to 5 days after application. It is used most often against chewing insect pests (plum curculio, Japanese beetle, leafrollers, etc.). Rotenone is highly toxic to bees and should not be used during bloom.

Pyrethrins are a family of compounds derived from a tropical pyrethrum daisy. They are “contact poisons” (they do not have to be eaten by insects to be toxic). They remain effective on treated plants for only a matter of a few hours—they give no residual control. Pyrethrins are sometimes used against aphids and other “sucking” insects.

Neem (azadirachtin) is derived from bark or seeds of the tropical neem tree. It interferes with normal growth in insects and discourages their feeding, but it does not kill all insects immediately. Neem is sometimes used against caterpillar pests (leafrollers, codling moth, etc.) and against leafhoppers and stink bugs.

Garlic oils and extracts have been found to be ineffective in virtually all field trials against insect pests of fruits and vegetables. Despite countless advertisements to the contrary, we do *not* recommend their use.

Microbial insecticides available for use in fruit crops contain preparations of the bacterium *Bacillus thuringiensis* (Bt). Insecticides containing Bt are effective against caterpillars that ingest treated plant parts; these Bt products are not toxic to other insects. Spray residues usually remain effective for 2 to 5 days before they break down in ultraviolet light. Bt applications are effective against leafrollers and grape berry moth (if applied repeatedly) but usually not against codling moth larvae or peachtree borers because these insects feed very little if at all on treated plant surfaces before boring into fruits or trunks.

Plant spray oils include Superior oil (used on dormant plants to smother overwintering San Jose scales and eggs of European red mites and rosy apple aphids) and more highly refined summer oils, such as Sunspray UFO. Summer oils also block the “breathing” openings on insects’ bodies, smothering or suffocating them as a result. They are most effective against inactive or slow-moving, soft-bodied pests such as mites and aphids. Be careful to read product labels for precautions on plant injury; oils applied at the wrong time or at too high a concentration may damage treated foliage.

Soaps (made from plant fatty acids) also kill insects by disrupting their breathing system. Soaps enter the spiracles (air openings) and injure the tubes that carry air. Soaps work only against the insects that are sprayed directly or that contact the sprayed surface while it is still wet. They provide no residual effectiveness. Common targets are mites and aphids. Like oils, soaps may injure plant foliage, so read and follow all label precautions.

Surround (trade name) is a new product that contains kaolin (clay) particles; it is applied as a “particle film” to plants, presumably blocking insects’ recognition of plant cues or contaminating the insect cuticle. Relatively few evaluations of Surround have been completed; it appears to be partially effective against codling moth, plum curculio, and a few other pests of apples.

Diatomaceous earth is the ground-up silica-rich cell walls of microscopic organisms called diatoms. This material is abrasive to the cuticle (body covering) of insects, causing greater loss of body water than normally occurs through the body surface. Diatomaceous earth can be used to protect stored materials in dry environments, but it is not effective in outdoor uses, where it is pretty much deactivated by rainfall or dew.

Conventional Synthetic Insecticides

Many synthetic insecticides are labeled for use on fruit crops, but most are not packaged in small containers for sale to homeowners; some (not those listed below) are sold only to trained, licensed applicators. The insecticides listed below usually are available in garden supply stores and similar retail outlets.

Carbaryl is sold under several trade names, but it is best known as Sevin. It is effective primarily against insects with chewing mouthparts (beetles and caterpillars), and it remains effective for about 3 to 5 days after application. It is not effective against aphids; and, because it kills the predators of European red mites, mite outbreaks sometimes occur where Sevin is used. It is highly toxic to bees and should not be used during bloom. Sevin also causes fruit drop in apples if it is applied within 30 days of full bloom.

Malathion is moderately effective against insects with sucking mouthparts, and it is used most often in fruit crops against aphids. It is also useful for Japanese beetle control in raspberries and blackberries. It remains effective for 2 to 3 days after application.

Methoxychlor is reasonably effective against insects with chewing mouthparts (caterpillars and beetles), and it remains effective for 3 to 4 days after application. Methoxychlor is less toxic to honeybees than the other insecticides listed here.

Diazinon is effective against a broad range of insects, including caterpillars, beetles, aphids, and scale crawlers. It is also effective as a trunk and scaffold branch spray

to peaches, plums, and cherries to control peachtree borer and lesser peachtree borer. Diazinon is *not* approved for use on blackberries, raspberries, or blueberries. Diazinon is no longer manufactured for sale to homeowners; but, because existing supplies may still be sold and used, we continue to include it in the information that follows.

Phosmet is sold under the trade name Imidan, and it is effective against a broad range of fruit pests. It remains effective for 7 to 10 days after application. It controls plum curculio, Oriental fruit moth, apple maggot, and codling moth—four of the most damaging insect pests of tree fruits in Illinois. It may be used on tree fruits, grapes, and blueberries but not on raspberries, blackberries, or strawberries. Imidan is highly toxic to bees and should not be applied to blooming plants.

Fungicides

As mentioned previously, fungicides are pesticides that control diseases caused by fungi. Fungal infections occur when the spores of the fungus are present and the environmental conditions are favorable for the particular pathogen. Moisture, whether in the form of rainfall, dew, or humidity, is often one of the necessary ingredients for a fungal infection to occur. Most fungicides act as a protective barrier on the leaf and fruit surfaces and therefore often must be in place *before* the disease occurs. When possible, fungicides also must be applied just before a prolonged wet period occurs, not after. Once disease symptoms appear, it is generally too late to “cure” the problem; however, additional fungicide sprays may still be required to prevent further disease increase. Table 8 compares the relative effectiveness of selected fungicides against specific diseases of various fruit crops.

Bordeaux mixture is a combination of copper sulfate and hydrated lime. It is most useful as a dormant spray on apples and pears for fire blight and as a dormant spray on peaches for peach leaf curl and bacterial spot. It is not compatible with many other pesticides and can injure plant tissue if applied incorrectly. *Be especially diligent in following ALL label directions.*

Benomyl (Benlate) is a locally systemic fungicide labeled for vegetable and fruit diseases. It is excellent for control of apple scab, powdery mildew, and sooty blotch and flyspeck, as well as various apple fruit rots. On stone fruits, it controls brown rot, scab, and cherry leaf spot. On brambles and strawberries, it controls leaf spots, powdery mildew, fruit rots, and cane diseases. On grapes it controls black rot and powdery mildew. *Note:* Where Benlate is not available for home use, see the comments for thiophanate-methyl (trade names Cleary's 3336 and Topsin-M).

Captan is the primary fungicide found in home fruit spray mixtures such as Fruit Guard, Fruit Tree Spray, Home Orchard Spray, etc. It can also be purchased separately as Captan or Orthocide and combined with insecticides. An effective and reliable fungicide, it controls apple scab and most summer leaf and fruit-spotting apple diseases. It is effective for brown rot control of stone fruits, strawberry leafspots, grape black rot, and grape downy mildew. *Note:* *Captan is not compatible with oil; do not apply captan within 7 to 10 days of an oil application on apples because leaf injury may result.*

Chlorothalonil (Daconil 2787) is an excellent multipurpose fungicide that can be used on a wide variety of fruit crops, as well as vegetables, lawns, trees, shrubs, and flowers. Chlorothalonil is sold under a variety of brand names, such as Daconil 2787, Ferti-lome Liquid Fungicide, Ortho Multipurpose fungicide, and other trade names. It has numerous uses in the home fruit planting; however, it is not labeled for control of apple diseases (other than for flowering crabapples).

Coppers, or copper-based fungicides (with numerous trade names), are labeled for fruit, vegetables, and ornamentals. They are especially good for peach leaf curl and early diseases of apple and grape. Along with sulfur, the copper-based fungicides are generally considered safe by organic gardeners. They can injure plant tissue if applied incorrectly. *Be especially diligent in following ALL label directions.*

Ferbam is effective against a wide range of fruit diseases. It is especially effective in control of cedar apple rust, apple summer rots, black rot of grape, and peach leaf curl. A black residue may remain on the fruit if ferbam is used late in the season.

Lime-sulfur (Dormant Disease Control) is generally applied just before new spring growth appears. If applied to green foliage, it may cause severe burn. It is excellent as a dormant spray on peaches for peach leaf curl and on raspberries and blackberries for cane blight, spur blight, and anthracnose.

Thiophanate-methyl (Cleary's 3336, Topsin-M) is a locally systemic fungicide very similar in activity to benomyl. Topsin-M is primarily packaged and labeled for commercial fruit plantings. Cleary's 3336 is packaged and labeled for backyard home fruit plantings; it also may be used on ornamental plantings. See the label for a complete listing of uses.

Sulfur is sold both as a dust and in wettable power form. Sulfur is especially good in the control of powdery mildew; however, use with care on certain grape varieties (see the label). Along with copper, sulfur is generally considered acceptable for organic gardeners.

Bactericides

The previously mentioned fungicides do not control bacterial diseases such as fire blight. The exceptions to this are copper-based materials such as Bordeaux mixture. However, copper materials often cause blemishes on the surface of fruit and/or provide poor control. Specific antibiotics, such as streptomycin sulfate, provide the best control of bacterial diseases. To control fire blight, apply streptomycin alone (not combined with other chemicals) several times during the bloom period. Follow all label directions.

Instructions and Tips for Spraying

Safety Concerns

- Always read and follow all label directions.
- Keep pesticides in their original containers and lock them away from children, pets, foods, and feeds.
- Do not breathe in spray mists or dusts, and do not allow pesticides to contact your skin. Wear rubber gloves, long sleeves and long pant legs, goggles, and a cap when mixing and spraying pesticides. Mix sprays in a well-ventilated area to avoid breathing fumes. Wash thoroughly with soap and water if pesticides splash onto your skin.
- Don't eat or smoke while handling or spraying pesticides.
- Don't spray while standing under the tree canopy: Gravity works, and you'll be treated, too.
- Don't allow spray to drift onto other plants, birdbaths, fish ponds, or water supplies.
- Thoroughly rinse and dispose of pesticide containers in a manner that prevents their re-use.
- Wash thoroughly with soap and water after you finish applying pesticides; also launder clothing immediately after spraying.

Effective Insect and Disease Control

- The spray schedules that follow list the timing for application of particular insecticides and fungicides to produce insect- and disease-free fruit. If 100 percent perfect fruit is your goal, do not skip any of the sprays listed. For most home fruit growers, however, 100 percent perfect fruit is not the goal. If you are

willing to cull out a few infested or damaged fruits, pay particular attention to the remarks about when a spray is usually not needed.

- Good spray coverage is essential for good pest control. Thoroughly wet the upper and lower surfaces of leaves, the fruit, limbs, and trunk. In fruit trees, direct two-thirds of the spray into the upper one-third of the tree canopy. See Table 1 for the amount of spray for different sizes of trees.
- If leaves or fruits are waxy, sprays may bead up and not spread out evenly. To provide for more even spread, after filling the sprayer, add 1 teaspoon of liquid household detergent per gallon of spray mix.
- Never put herbicides (weed killers) into sprayers that are to be used for insecticides or fungicides. Herbicide residues that remain in the tank may damage fruit crops when the sprayer is used next.
- For optimal disease control, spray before rains and allow sufficient time for the spray to dry before rainfall begins. Most disease-causing organisms infect wet plants.
- Prepare just enough spray mix for each application; never save a spray mix for later use.
- Shake small sprayers frequently during application to keep the pesticide evenly suspended in the tank.
- Rinse the sprayer immediately after use. Do not wait until the next day or later because the spray mix that dries in the nozzle(s) may cause clogging.
- During bloom, fungicides may be used for disease control, but do not apply insecticides. Most insecticides kill honeybees and other necessary pollinators.
- Most home fruit pesticides are mixed at concentrations of 1 to 3 tablespoons per gallon or 1 to 2 cups per 10 gallons. **To determine the proper dilution, read the label on the package or bottle.** The “strength” of available formulations of the same active ingredient differs, so it is not possible to list the correct mixing rate in the spray schedules that follow.

Preventing Mouse Damage

Mice are serious pests of apple and, sometimes, other fruit trees. They eat bark from the trunk near and below the groundline and from the roots. Young and old trees can be damaged. Mouse injury is usually more serious in the late fall, winter, and early spring—when other food is scarce.

Predators such as cats, hawks, owls, and foxes can greatly reduce the mouse population if protective cover is eliminated. Mow the grass closely, especially under the trees, and kill all grass and weeds within 1 foot of the trunk.

Mulches are advantageous for fruit trees, but they harbor mice. In autumn, remove mulch to leave 1 foot of bare ground around each tree.

TABLE 1. Approximate Amount of Spray Required for Fruit Trees of Various Sizes

Height in feet	Spread in feet	Gallons per tree per application ^a
4	3	up to 1/2
5 to 8	3 to 6	1/4 to 1
8 to 10	4 to 8	1/2 to 1
10 to 15	8 to 15	1 to 3
15 to 20	15 to 25	2 to 6

^aUse the larger amount for trees in full foliage.



Prairie vole

Mouse traps and poisons may be used. A repellent on the trunk near the ground-line also can help protect trees from mouse damage. Use a commercially prepared rabbit repellent that contains thiram. Spray or paint the lower trunk in late November and again in February.

A gravel collar around the tree trunk discourages mice and helps control grass and weeds. The collar should be made of "pea gravel" and be 6 to 8 inches deep and about 2 feet in diameter. The gravel should remain loose to prevent damage to the trunk.

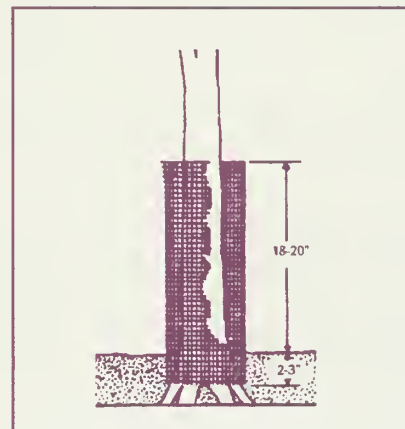
Preventing Rabbit Damage

In fall, winter, and early spring—when food is more scarce—rabbits feed on the bark of the trunk and lower limbs of fruit trees. They also eat the bark from blackberry and raspberry bushes and the buds on young blueberry plants. Rabbits seldom cause much damage to older fruit trees or blueberry plants.

Mechanical barriers prevent rabbit damage unless deep snows occur. For young trees, use a cylindrical metal guard (18 inches tall and 6 inches in diameter) made from an 18-inch square of hardware cloth. Or wrap the trunk and lower branches with several layers of newspaper in early November, and remove the papers in April.

The most practical mechanical barrier for protecting blackberry, raspberry, and young blueberry plants is a chicken-wire fence 18 to 21 inches tall.

Commercially prepared repellents that contain thiram are effective. In October or November, paint or spray the parts of plants that need protection from rabbits.



Wire mesh around tree trunk

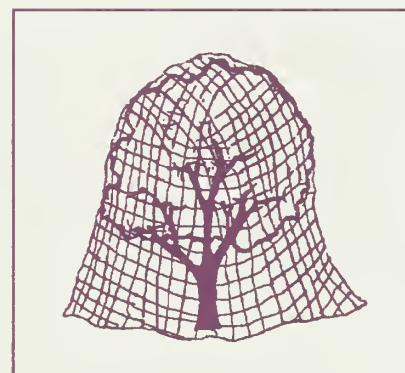
Preventing Bird Damage

Birds are especially destructive pests of blueberries and cherries, and they frequently damage other fruits. Because it is illegal to kill songbirds, covering plants with netting prior to fruit ripening is the only practical method of reducing losses. Picking fruit promptly is suggested.

Aluminum pie pans and other reflecting objects (scare eyes, owl decoys, rubber snakes) hung in fruit plants provide some protection, but birds become accustomed to their presence.

Additional Information

Many references that are available in bookstores and at garden supply stores provide additional information on pests of fruit plants. Among them, *The Backyard Orchardist* by Stella Otto, Ottographics, Maple City, MI, ISBN 0-9634520-3-7, is especially useful. The *Midwest Tree Fruit Pest Management Handbook* and the *Midwest Small Fruit Pest Management Handbook* provide background information on insects, diseases, and weeds in fruit crops. These publications are available for purchase from the University of Illinois, ACES/ITCS Marketing and Distribution, 1917 S. Wright St., Champaign, IL 61820; (800)345-6087.



Netting over fruit tree

Authors

R. Weinzierl

Department of Crop Sciences and the Illinois Natural History Survey

S. Ries

Department of Crop Sciences (retired)

Portions of this chapter were adapted from Purdue University's *Managing Pests in Home Fruit Plantings*, ID-146, by R. Foster, P. Pecknold, and B. Bordelon.

TABLE 2. Spray Schedule for Apples, Crabapples, Pears, and Quinces

Time to spray	Pest(s)	Pesticide	Remarks
Delayed dormant: When leaf tips start to protrude from buds	scales aphids mites	Superior oil	If these pests were not a problem last year, omit this spray. Mix at a concentration of 1 to 2% by volume. Apply only when the temperature will not drop to freezing for 24 hours.
Half-inch green: 1/2 inch of green tissue	apple scab	Captan or MPFS ^a	Insects are not usually a problem before petal fall.
Tight to open cluster: When fruit buds are visible	apple scab	Captan or MPFS	<i>Apples only:</i> If rainy weather prevails, apply additional sprays between this and pink spray.
Pink: Just before any blooms open	apple scab	Captan or MPFS	<i>Apple only:</i> If cedar rust has been a problem, add ferbam or thiram to this and the next two sprays.
Bloom: When 50% of blossoms are open	apple scab	Captan	Do not use MPFS during bloom. If fire blight has been a problem, use streptomycin according to label directions.
Petal fall: When 75% of petals have fallen	plum curculio apple scab sooty blotch fly speck	Imidan plus Captan or MPFS	This is a very important spray for plum curculio control. Wait until honeybee foraging has ended before making this spray.
First cover: 7–10 days after petal fall	plum curculio codling moth apple scab sooty blotch fly speck	same as petal fall spray	To prevent fruit drop, do not use Sevin within 30 days after full bloom.
Second cover: 7–10 days after first cover	plum curculio codling moth apple maggot apple scab sooty blotch fly speck	same as petal fall spray	Apple maggot flies begin to emerge about mid-June. Use red sticky balls to tell when maggot flies are present. They are a problem only in the northern half of Illinois.
Additional cover sprays: Apply at 2-week intervals until harvest-restriction date.	apple scab fruit rots sooty blotch fly speck codling moth apple maggot Japanese beetle	Captan plus Imidan or Diazinon or Sevin or MPFS	Read container label for number of days between final spray and harvest.

Note: Borers that attack apple and pear trees are controlled by this spray schedule if the trunk is thoroughly sprayed. If borers have attacked young, nonbearing trees, spray the trunks every 2 weeks during June and July with diazinon or a MPFS. For apple maggot control in the northern half of Illinois and codling moth control throughout the state, continue to apply an insecticide or multipurpose fruit spray every 10 to 14 days through July and August.

^aMPFS = multipurpose fruit spray.

TABLE 3. Spray Schedule for Grapes

Time to spray	Pest(s)	Pesticide	Remarks
When buds begin to swell	flea beetle climbing cutworm anthracnose	Sevin <i>or</i> methoxychlor <i>or</i> MPFS ^a lime-sulfur	For flea beetle or cutworm control if present. To reduce overwintering inoculum.
When new shoots are 2–4 inches long	flea beetle black rot downy mildew	Captan plus Sevin <i>or</i> MPFS	
When new shoots are 8–10 inches long	rose chafer black rot	Captan plus Sevin <i>or</i> MPFS	If rainy conditions prevail, additional sprays for black rot may be required.
Just before blossoms open	rose chafer black rot downy mildew	Captan plus Sevin <i>or</i> MPFS	
Just after blossoms have fallen	grape berry moth black rot downy mildew	Captan plus Sevin <i>or</i> MPFS	If powdery mildew is a problem, add thiophanate-methyl or sulfur in post-bloom sprays.
When grapes are the size of small peas	grape berry moth black rot downy mildew	Captan plus Sevin <i>or</i> MPFS	
As needed if problems occur	grape berry moth	Sevin <i>or</i> MPFS	Read container label for number of days between final spray and harvest.

Note: Grapes must be pruned and retied annually. Clean cultivation helps control flea beetles, cutworms, and disease-causing organisms. Select strong, healthy canes of the previous year's growth to produce the following season's crop. After the fruiting canes have been selected, remove excess growth, dried berries, and leaves. Destroy (burn) all prunings. The most important problem is black rot, which appears on the leaves as small, reddish brown to tan-brown spots with dark margins. "Bird's-eye" tan spots on the fruit rapidly enlarge. Berries quickly rot and turn into black, wrinkled mummies that drop early.

^aMPFS = multipurpose fruit spray.

TABLE 4. Spray Schedule for Blueberries

Time to spray	Pest(s)	Pesticide	Remarks
As buds break open and until three-fourths of the blossoms have dropped	mummy berry Botrytis blight	Benlate plus Captan	Application of insecticides is rarely necessary in blueberries in Illinois. If pest problems appear, apply Malathion or Sevin according to label directions at 10-day to 2-week intervals.

Note: Pruning out old canes and removing small, weak, diseased wood with hand shears reduce insect, mite, and disease problems. All prunings should be removed and disposed of, preferably by burning. Heavy nitrogen fertilization increases the chances for more severe disease problems.

TABLE 5. Spray Schedule for Peaches, Nectarines, Apricots, Plums, and Cherries

Time to spray	Pest(s)	Pesticide	Remarks
Dormant: Before buds swell in spring (peaches only)	peach leaf curl black knot	lime-sulfur	See description of lime-sulfur in "Fungicides" section on pages 128 to 129..
Prebloom: When blossom buds show pink	brown rot (blossom blight)	Captan or MPFS ^a	Insects are not usually a problem before petal fall.
Bloom	brown rot (blossom blight)	Captan	If rainy weather occurs during bloom, apply additional sprays of Captan to control brown rot. To protect bees, do not apply insecticides during bloom.
Petal fall: When 75% of petals have fallen	brown rot cherry leaf spot plum curculio Oriental fruit moth	Captan plus Imidan or Sevin or MPFS	Most important spray for plum curculio, which attacks most tree fruit crops. Cherry leaf spot is only on cherry.
Shuck split: When most shucks have split apart	brown rot cherry leaf spot plum curculio Oriental fruit moth	Same as petal-fall spray	Important spray for plum curculio. Good control of curculio helps improve control of brown rot.
First cover: 10 days after shuck split	brown rot cherry leaf spot plum curculio cherry fruit fly Oriental fruit moth	Same as petal-fall spray	Cherry fruit fly on cherry only.
Additional cover sprays: Apply at 2-week intervals.	brown rot cherry leaf spot cherry fruit fly Oriental fruit moth	Same as petal-fall spray	
Preharvest sprays: Apply according to label directions, beginning 3 to 4 weeks before harvest.	brown rot	Captan or MPFS	Read container label for number of days between final spray and harvest.

Note: For special borer sprays for peaches, nectarines, cherries, plums, and apricots, spray or paint only the trunk and lower limbs with 3 table-spoons of Sevin per gallon of water about June 15, July 15, and August 15. Alternatively, apply sprays of diazinon.

^aMPFS = multipurpose fruit spray.

TABLE 6. Spray Schedule for Strawberries

Time to spray	Pest(s)	Pesticide	Remarks
Prebloom: When first blossom buds appear in the spring	gray mold leaf spots spittlebug tarnished plant bug	Captan plus Sevin or MPFS ^a	To achieve better control of gray mold (<i>Botrytis</i> fruit rot) and other fruit rot diseases, maintain a thick layer of straw mulch between rows, making sure no bare ground is visible.
Early bloom: Every 10 days until first blooms start to open	gray mold leaf spots spittlebug tarnished plant bug	Captan plus Sevin or MPFS	Apply insecticides only if these pests are present and causing damage.
Full bloom	gray mold other fruit rots leaf spots	Captan	Important spray for gray mold. <i>No insecticides during bloom.</i>
Postbloom: Begin 10 days after full bloom and continue every 7 days until harvest.	gray mold leaf spots tarnished plant bug leafrollers	Captan plus Sevin or MPFS	Check label for days between final spray and harvest. Apply an insecticide only if needed.
Harvest	gray mold	Captan or MPFS	If wet, cool weather occurs at harvest, repeat Captan sprays as needed, even between pickings. <i>Check label for harvest and reentry restrictions.</i>
Postharvest	leaf spots leafrollers leafhoppers	Captan plus Sevin or MPFS	Products containing <i>Bacillus thuringiensis</i> can be used to control leafrollers.

Note: To reduce insect and disease problems of strawberries, do the following:

1. Renovate beds annually, immediately after harvest.
2. Use certified, virus-free plants for new plantings. Plan a good aphid-control program during spring and summer to reduce the chance of contaminating your virus-free plantings. Malathion is recommended against aphids.
3. Practice crop rotation. Because of the possibility that *Verticillium* wilt may develop, avoid planting strawberries within 3 years of planting tomatoes, peppers, potatoes, eggplant, melons, or roses. Strawberry varieties most resistant to *Verticillium* wilt include Allstar, Catskill, Delite, Earliglow, Guardian, Redchief, Sunrise, Surecrop, Tennessee Beauty, Tribute, and Tristar.
4. Plant red stele-resistant varieties; this is the only control for this disease. Planting in light, well-drained soil is recommended. The following strawberry varieties are resistant to red stele root rot (the number in parentheses is the number of races of the fungus to which the variety is resistant): Allstar (2), Darrow (5), Delite (5), Earliglow (5), Guardian (5) Midway (2), Redchief (5), Sunrise (5), Surecrop (5), Tribute (2), and Tristar (2).
5. Avoid white grubs. Do not plant strawberries on sod land until it has been under cultivation at least 2 years. If grub damage is present, apply diazinon as a postharvest treatment.
6. If slugs are a problem, apply metaldehyde bait according to label directions.

^aMPFS = multipurpose fruit spray.

TABLE 7. Spray Schedule for Brambles (Blackberries and Raspberries)

Time to spray	Pest(s)	Pesticide	Remarks
Delayed dormant: When tips of buds show green	anthracnose	lime-sulfur	Very important spray for control of anthracnose. Sprays applied after 1/2 inch green may burn foliage. Remove and destroy infected canes.
Prebloom: Apply 1 week before bloom.	raspberry sawfly raspberry fruitworm caneborers	Sevin	Do not apply any insecticides during bloom.
Postbloom: Apply immediately after bloom.	red-necked caneborer	Sevin	Although Sevin is listed here and postharvest, these sprays usually are not necessary in home plantings.
Preharvest: Begin 10 days after full bloom, and continue every 7 days until harvest.	sap beetles Japanese beetle	Sevin Malathion	For sap beetles: Keep berries off the ground and ripe berries picked. Set up bait buckers with overripe fruit outside of the planting area. Destroy contents of buckets regularly. Spray for Japanese beetles whenever they are numerous on foliage and fruit.
Postharvest: After harvest is completed and old canes removed		Sevin	Prompt removal of old canes after harvest is essential to prevent disease spread.

Note: To reduce insect and disease problems of brambles, do the following:

1. Remove and dispose of insect-infested, diseased, and old fruiting canes immediately after harvest. Thin out all weak, short, spindly, and injured canes. Clean cultivation helps control fruit worms.
2. Remove all nearby wild brambles and neglected plantings.
3. Keep fruit plantings and surrounding areas free of weeds.
4. Use certified, virus-free plants when starting a new planting. Select adapted, disease-resistant varieties.
5. All plants infected with orange rust, crown gall, and viruses must be dug out and removed from the planting when first noticed.
6. See the spray schedule for strawberries (Table 6) for note on Verticillium wilt control.

TABLE 8. Relative Effectiveness of Selected Fungicides Against Specific Diseases of Various Fruit Crops

Fruits and diseases	Benomyl (Benlate)	Captan	Wettable sulfur
Apple			
Scab	xxx	xx	x
Cedar rusts	0	0	0
Powdery mildew	xxx	0	xxx
Sooty blotch, flyspeck	xxx	xx	x
Stone fruits			
Brown rot of peach, plum, cherry, apricots	xxx	xx	x
Peach scab	xxx	xx	xxx
Strawberry			
Leaf spots and blights	xxx	xx	—
Gray mold	xxx	xx	—
Grape			
Black rot	x	xx	0
Downy mildew	0	xxx	0
Powdery mildew	xxx	0	xxx
Raspberry			
Fruit rot, anthracnose, spur blight, cane blight	xxx	xx	

Note: xxx= very good, xx = good, x = fair, 0 = not effective, and — = not labeled for this use.



CHAPTER 7



INTEGRATED PEST MANAGEMENT AND PESTICIDE SAFETY

Integrated Pest Management for Homeowners

Integrated pest management (IPM) deals with pests (that is, insects, diseases, and weeds), using one or a combination of cultural, physical-mechanical, chemical, and biological management strategies. The combination of environmental and economical management strategies is not aimed toward eliminating pests but keeping pest numbers low enough so that damage is not evident. IPM does not mean the elimination of pesticides; however, it does promote the use of pesticides only when needed—that is, after other management options have been considered. The key in determining the effectiveness of IPM strategies is monitoring pest populations.

Monitoring

Monitoring involves detecting pest populations by using a trapping device, by visually inspecting plants, or by both means. Yellow sticky cards are trapping devices that are placed above or within the plant canopy. Sticky cards attract flying insects such as moths, beetles, thrips, and whiteflies. In addition, sticky cards capture parasitic wasps and predatory beetles. Sticky cards should be checked once a week and the number of insects counted. A 10X hand lens can be used to identify small insects.

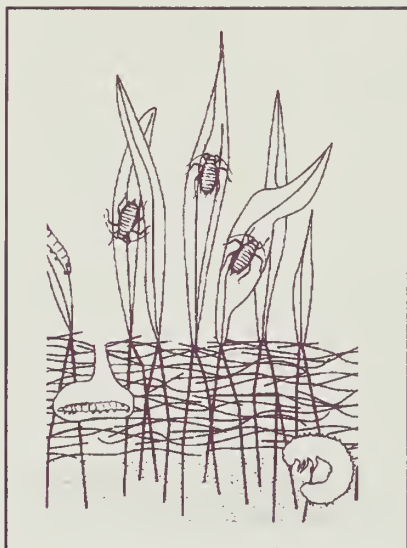
Visual inspection relies on looking at plant parts for insects, mites, and diseases. It includes checking leaf undersides, terminal shoots, buds, and flowers. A method to monitor for spider mites, for example, is to shake a branch over a white sheet of paper. Any spider mites fall off, land on the paper, and crawl around.

Both trapping and visual inspection are useful for determining the effectiveness of management options used in the landscape and garden.

It is important to identify the pest responsible for damage observed. Indirect evidence may not indicate the presence of a pest. For example, holes in leaves may be caused by late frost damage, not by chewing insects or a foliar disease. Pest identification is also important because some insects and diseases are more damaging than others. Once you know what kind of pest is present, you can better judge if the potential damage justifies management.

The information in this chapter is provided for educational purposes only. Product trade names have been used for clarity, but reference to trade names does not imply endorsement by the University of Illinois; discrimination is not intended against any product. The reader is urged to exercise caution in making purchases or evaluating product information.

Label registrations can change at any time. Thus the recommendations in this chapter may become invalid. The user must read carefully the entire, most recent label and follow all directions and restrictions. Purchase only enough pesticide for the current growing season.



Population size

Knowing the number of pests present can help you estimate their impact and determine whether or not there is sufficient cause to spend time and money on management. The amount of damage generally depends on the number of pests. For example, a small number of white grubs in a vegetable garden may cause heavy damage to root crops such as potatoes, carrots, and onions but cause no yield loss to nonroot crops such as tomatoes, beans, and cabbage.

Cultural Management

Cultural management focuses on preventing or minimizing pest problems by maintaining plant health through proper watering, fertilizing, mulching, pruning, and planting time. This approach also includes using plants that tolerate pests, plants that show host-plant resistance. Two other cultural management strategies are site selection and sanitation.

Proper selection of a planting site results in healthy plants that are better able to defend themselves and are less susceptible to pest attack. Be sure to consult available sources for information on proper planting zone, soil conditions, soil pH, mature plant size, and other factors before selecting and planting. Sanitation includes removing plant debris (that is, leaves), which may serve as a hiding area or source for insects, mites, and diseases. Many insects, mites, and diseases overwinter on plant debris. Another sanitary practice, weed management, is important, especially for young plants, as weeds compete for water and nutrients. Hand-pulling, hoeing, or using an herbicide can reduce existing weeds.

Proper watering and fertilizing minimize plant stress, reducing susceptibility to many diseases and some insect pests, such as wood-boring beetles. For example, healthy pines and other conifers can compartmentalize, or seal off, the larvae of wood-boring beetles, preventing the insects from causing severe injury. Water plants thoroughly during drought conditions. However, be careful to not overwater. Constantly wet conditions can result in rotting roots. Apply only the recommended amount of fertilizer to herbaceous plants, trees and shrubs, and turfgrass. For example, certain turfgrass diseases such as brown patch (*Rhizoctonia solanii*) are favored by excessive nitrogen.

Mulches keep areas around plant roots free from competing weeds, retain moisture, and prevent lawn mowers and weed-whackers from damaging the base of trees and shrubs. However, too much mulch or mulch that covers the plant crown (base) can cut off oxygen and suffocate the plant. Getting too little oxygen stresses the plant and increases susceptibility to opportunistic insects and diseases.

Pruning maintains plant health by removing dead, diseased, and dying plant parts. Pruning allows more sunlight to enter the canopy and increases air circulation. Each of these conditions results in fewer leaf disease problems. However, improper pruning, such as topping or leaving "stubs," can increase the likelihood of insect and disease attack.

Selecting the proper planting time is another way to minimize problems with pests. Planting early or late (when pests are less abundant) prevents or minimizes damage. For example, planting zucchini squash early allows more of the crop to be harvested before damage by squash vine borer can occur.

Planting varieties or cultivars that are less susceptible to pests or more tolerant of them is another way to reduce pest problems. For example, if tomato plants are labeled with the letters VFN, it indicates that they are able to tolerate the soil-borne diseases *Verticillium* and *Fusarium*, as well as a root-feeding nematode. Certain plants can tolerate high pest numbers without showing any noticeable damage. In addition, some plants produce chemicals that deter insects from feeding on them, while other plants have long hairs or other physical characteristics that make it difficult for insects and mites to feed.



Birch branch

Physical Management

Physical management includes pulling and hoeing weeds, stepping on slugs or beetles, and washing aphids or mites from plants. Physical management can be as simple as pruning off infested branches to remove insects or diseases. Pruning branches can control the larvae of tent caterpillars and their overwintering egg masses, scales, and fire blight. Some pests are not controlled with chemicals, so physical removal is the only option. For example, gouty oak gall (which is caused by an insect) and the disease black knot of cherry can be managed only by pruning out infested plant parts.

Barriers can keep pests from reaching plants and causing damage. Tin cans or strips of cardboard placed around young tomato plants can be used to keep out cutworms. Mechanical devices can also be used to manage insect pests. For example, flyswatters are effective in killing flies and other home-invading pests. In addition, handheld vacuum cleaners work well in removing household nuisance pests such as the Asian lady beetle and earwigs.

Physical management is an environmentally sound strategy that rapidly removes or kills pests.

Chemical Management

Chemical management is the use of insecticides, fungicides, herbicides, and other pesticides to control pests. These substances can be synthetically derived (human-made) or biorational pesticides. Pesticides can also be classified as either contact or systemic.

Contact pesticides directly kill pests through physical contact. Effectiveness of these materials depends on thorough spray coverage. In addition, contact materials with short residual properties may require repeat applications.

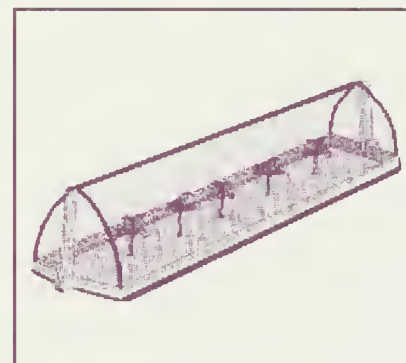
Systemic pesticides are applied to the leaves, stem, or soil. The active ingredient is taken up and moved throughout the plant. Systemics generally take longer to work but last longer than contacts. Systemic insecticides are effective against sucking insects such as aphids, whiteflies, mealybugs, and soft scales. In addition, they are less harmful to natural enemies than are contacts. Roundup (glyphosate) is a systemic, or translocated, herbicide that is useful in controlling troublesome weeds because it moves from the leaves to the root system and thus kills the entire plant.

Contact and systemic fungicides also are available.

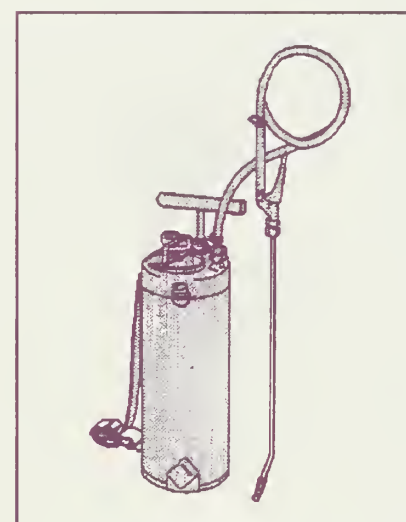
Synthetically derived pesticides are widely available to the general public at nurseries and garden centers. Synthetics include many insecticides, miticides, fungicides, herbicides, and rodenticides. Be sure to read the label carefully before applying any of these materials.

Biorational pesticides are generally more environmentally sound than synthetically derived pesticides. The biorationals include microtoxin (bacteria), insect- and plant-growth regulators, soaps and horticultural oils, and botanicals. The most widely used bacterial insecticides are those containing *Bacillus thuringiensis* (Bt) toxins. *Bacillus thuringiensis* materials are used because they have short residual activity and are specific to the types of insects controlled (Table 1).

Bt materials must be eaten by the pest to work. Because Bts are rapidly broken down by ultraviolet light, repeat applications may be necessary. These materials are important components of an IPM program because they have minimal effect on beneficial insects and mites (the natural enemies of pests).



Plant cover



Hand can sprayer

TABLE 1. *Bacillus thuringiensis* (Bt) Types and Insect Groups They Are Used On

Bt type	Insect group
<i>Bacillus thuringiensis</i> var. <i>israelensis</i>	mosquitoes and black flies
<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> (Dipel and Thuricide)	caterpillars
<i>Bacillus thuringiensis</i> var. <i>tenebrionis</i>	leaf-feeding beetles

Insect-growth regulators (IGRs) and plant-growth regulators (PGRs) are used to control certain pests. Insect-growth regulators keep insect pests in a young stage or cause them to molt prematurely. These substances have no direct activity on adult insects but can cause infertile eggs to be laid. Plant-growth regulators disrupt normal plant growth, which results in reduced flowering and seed production and subsequent death. The plant-growth regulator 2,4-D is available in many herbicide combinations used in landscapes, gardens, and turfgrass to control broadleaf weeds. It kills plants by overstimulating growth.

Soaps and horticultural oils are used in IPM programs because they have short residual activity and minimal effect on natural enemies of pests. Soaps are contacts that kill insects and mites by disrupting cell membranes and causing desiccation (drying). There are soap formulations that kill moss, algae, and weeds. Herbicidal soaps work better on young weeds than on older (mature) weeds. Horticultural oils have been refined so they can be used in summer as well as winter. Oils are contacts that work by smothering an insect's spiracles (breathing pores) and suffocating it. They have broad-spectrum activity, killing active and overwintering stages of insect and mite pests. In general, oils have activity on all life stages of insects: egg, larva, and adult. In addition, oils have activity on certain foliar diseases like powdery mildew. Caution should be exercised when using oils; making too many applications or applying when temperatures are above 80°F can result in plant damage.

Botanical, or natural, pesticides are derived from plant parts. These are usually contacts and tend to degrade quickly. Some botanical insecticides must be eaten by the pest to be effective. Despite being classified as "natural," they are just as toxic as synthetically derived pesticides. Examples of botanical materials for insect control are nicotine, pyrethrin, rotenone, sabadilla, ryania, and neem. Neem is a widely available insecticide that acts as a repellent and insect-growth regulator.

Avoid using the same insecticide continually year after year as this can lead to insect pests' developing resistance. In other words, the material will no longer effectively kill the pest. Use different insecticide types during the year, such as a microtoxin, insect-growth regulator, soap, oil, or botanical. In addition, use IPM methods that reduce insecticide use in landscapes and gardens.

Biological Management

Biological management uses living organisms (natural enemies) such as parasitic wasps, predators, and pathogens to control pests. A variety of natural enemies feed on insect and mite pests (Table 2).



Lady beetle

TABLE 2. Natural Enemies That Can Be Found in Landscapes and Gardens or Purchased

Parasitic wasps	Predators
<i>Aphidius</i> spp.	Damsel bugs
Braconid wasps	Green lacewing
<i>Encarsia formosa</i>	Ground beetles
Ichneumon wasps	Hover flies
<i>Trichogramma</i> spp.	Ladybird beetles
	Minute pirate bugs
	Predatory mites

Parasitic wasps insert their eggs into insects, the eggs hatch into young larvae that consume the insect's insides and then mature into adults that eat a hole in the dead insect and fly away. Parasitic wasps don't kill insects immediately, but they do reduce reproduction and fitness. Predators consume portions of or eat the entire insect. They generally feed on all insect stages, including eggs, young, and adults. Pathogens such as bacteria, fungi, and nematodes work similarly to parasitic wasps in that they use the insect pest as a food source by eating the internal contents. Both parasitic wasps and pathogens are slower acting than predators. Some insects are used to control thistles and aquatic weeds. Geese and other browsing animals feed on plants that are considered to be weeds.

Two biological management approaches are augmentation and conservation. Augmentation refers to the purchase and release of natural enemies to control an existing pest population. Augmentation can be divided into two strategies: inoculation and inundation. Inoculation is the release of low numbers of natural enemies over a long time. Offspring produced from the released individuals provide continued control. Inundation is the release of large numbers of natural enemies to reduce the pest population quickly. This strategy does not rely on offspring to provide additional or continued control. The reduction of pest numbers by inundation is similar to the level achieved with an insecticide.

Conservation preserves and retains existing populations of natural enemies. Conserving natural enemies can be accomplished by (1) growing plants that attract natural enemies and provide a food source (pollen and nectar) for adults (Table 3, page 145), (2) reducing the use of pesticides, (3) reducing the number of pesticide applications, and (4) using materials that are less harmful to natural enemies, such as bacterial toxins.

Another way to preserve natural enemies is to plant trap crops. Trap crops are plants, generally located around the perimeter of the landscape or garden, that attract insect pests; these insects then act as a reservoir for natural enemies. When the food source declines on the main plants, the natural enemies can migrate (move) back to the trap crop. For example, sweet alyssum (*Lobularia maritima*) is very attractive to aphids. These aphids then serve as a supplemental food source for parasitic wasps and predators.

IPM is an approach to reduce pest problems that uses a variety of methods—cultural, physical-mechanical, chemical, and biological. Foremost, it determines the need for action by monitoring pest numbers. This approach leads to an environmentally sound pest-management program for landscapes and gardens.

Pesticides in the Environment

The environment is our surroundings and its many forms of life. Water, air, soil, plants, humans, buildings, and wildlife are important parts of our environment. Anyone who uses a pesticide—indoors or outdoors, in a city or in the country—must consider how that pesticide affects the environment. Our environmental ecosystem is very complex, with many parts depending on one another. Any changes to the ecosystem can be potentially damaging. Pesticides can help or harm the environment, depending on how they are used. When used carefully and wisely, pesticides can help the environment by managing pests that could harm it. However, pesticide contamination of our natural resources is a real threat. It is important for pesticide users to be aware of the environmental risks and to use pest-management practices that keep these risks small.

Pesticides become environmental hazards when they move from where they should be, by air or water, or they contaminate nontarget plants or animals (Figure 1). Ideally, a pesticide should affect only the treated pests and last no longer than necessary to control them. To avoid environmental contamination, always follow the label. Problems occur when pesticides are used in a way other than as directed on the label or when an accident, such as a spill, occurs.

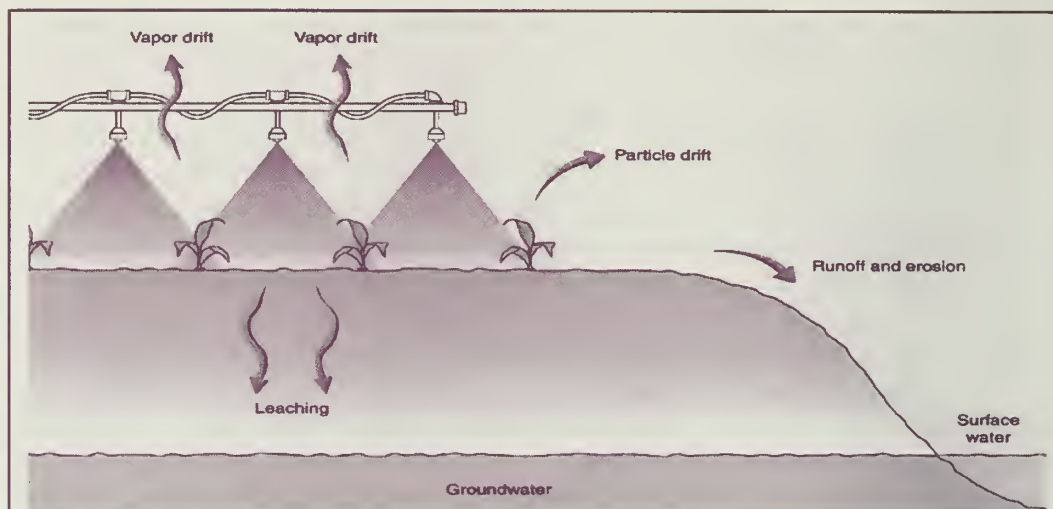


Figure 1. Pesticides become environmental hazards when they move.

◆ If you have a spill:

- Stop the spill.
- Attend to the injured (wear PPE).
- Contact the proper authorities.
- Remove spilled material.

Spills

Even when pesticides are handled properly, accidents still happen. Spills can occur and cause harm to whatever is in their path. It is important that you act immediately to stop the spill. However, make sure you are not putting yourself at harm in doing so. Be sure to wear protective clothing during cleanup. You may be able to stop the spill by merely setting a tipped-over container upright. Small containers may be placed in larger containers to help keep the leaks from spreading.

Next, attend to the injured with appropriate first aid. If a poisoning has occurred, notify a doctor. Immediately wash off any pesticide that has splashed onto the skin, and change clothes if they have been contaminated.

Use an absorbent material such as kitty litter, oil-dry, sawdust, or a special pesticide absorbent to soak up the spill. This method works well for spills on surfaces such as asphalt or concrete. For minor spills, shovel all contaminated material into a leakproof container for disposal. Dispose of it as you would excess pesticides. Then clean any contaminated areas with soap and water.

Spills, however, can occur in turf, and cleanup may not be as simple. In this situation, dilution with water may be the best option if, for example, a gallon jug of Roundup overturns. Removing the contaminated soil may be an option. Small quantities may be bagged and placed in the trash. However, large quantities may be difficult to dispose of. In the event of a major spill, you may need additional assistance. Check the label for emergency phone numbers. Also, you can contact proper authorities, such as local police or fire departments, the state police, Emergency Services and Disaster Agency (ESDA), or the Illinois Environmental Protection Agency for information on how best to handle the situation.

Misapplication

The misapplication of pesticides is a major concern to everyone. Usually it happens accidentally. Please remember that the pesticide label is a legal document and is based on scientific research. Misapplication can often be prevented just by carefully reading and following the label. Product labels sometimes give a range of application rates. If applications of the lowest rate are made, they can result in poor or inadequate control. Have no fear. You can refer to the label to see if an additional application can be made. Another application is often a possibility—as long as the maximum amount of active ingredient is not exceeded. However, just the opposite can occur, and an area can be overapplied. If this should happen, check the label for further instructions. There is a good possibility that you may not be able to harvest your crop. However, the safety of you and your family should come first. You can always replace the tomatoes that were ruined with ones from the supermarket.

TABLE 3. Plants That Can Be Used in Landscapes and Gardens to Attract Natural Enemies**Umbelliferae (Carrot Family)**

Caraway	<i>Carum carvi</i>
Coriander	<i>Coriandrum sativum</i>
Dill	<i>Anethum graveolens</i>
Fennel.....	<i>Foeniculum vulgare</i>
Flowering ammi/Bishop's flower	<i>Ammi majus</i>
Queen Anne's lace (wild carrot)	<i>Daucus carota</i>
Toothpick ammi.....	<i>Ammi visnaga</i>
Wild parsnip.....	<i>Pastinacea sativa</i>

Compositae (Aster Family)

Blanketflower.....	<i>Gaillardia</i> spp.
Coneflower.....	<i>Echinacea</i> spp.
Coreopsis	<i>Coreopsis</i> spp.
Cosmos	<i>Cosmos</i> spp.
Goldenrod	<i>Solidago</i> spp.
Sunflower	<i>Helianthus</i> spp.
Tansy	<i>Tanacetum vulgare</i>
Yarrow	<i>Achillea</i> spp.

Legumes

Alfalfa.....	<i>Medicago sativa</i>
Big flower vetch.....	<i>Vicia</i> spp.
Fava bean	<i>Vicia fava</i>
Hairy vetch	<i>Vicia villosa</i>
Sweet clover.....	<i>Melilotus</i> spp.

Brassicaceae (Mustard Family)

Basket-of-gold alyssum.....	<i>Aurinium saxatilis</i>
Hoary alyssum	<i>Berteroa incana</i>
Mustards	<i>Brassica</i> spp.
Sweet alyssum	<i>Lobularia maritima</i>
Wild mustard	<i>Brassica kabe</i>
Yellow rocket	<i>Barbarea vulgaris</i>

Other plant families

Buckwheat	<i>Fagopyrum sagittatum</i>
Cinquefoil	<i>Potentilla</i> spp.
Milkweeds	<i>Asclepias</i> spp.
Phacelia	<i>Phacelia</i> spp.

Movement of Pesticides by Air

Another form of misapplication is spray drift. Unfortunately, when you apply pesticides, there is always a chance some will escape from the target area. Drift is of concern because it removes the chemical from the intended target, making it less effective; and the chemical is deposited where it is not needed and often not wanted. The second concern is generally the more critical because the pesticide becomes an environmental pollutant in the off-target area. Off-target deposits can injure susceptible vegetation, damage wildlife, injure people, and contaminate air and water supplies. Problems can result when carelessly applied pesticides, especially

◆ What are the two types of drift?

- **Vapor drift:** Off-target movement of vapors produced up to several days after application
- **Particle drift:** Off-target movement of small particles or drops occurring during or after the application

◆ How can you reduce vapor drift?

- Apply when air temperatures are below 85°F.
- Choose a less volatile formulation. Amines are less volatile than esters.
- Work the pesticide into the soil if appropriate.

Watering in

Mechanically such as hoeing

◆ How can you reduce particle drift?

- Adjust equipment in order to produce large spray droplets.
- Make applications when winds are 3 to 10 mph.
- Avoid applications when conditions are hot with low humidity (conditions that favor droplet evaporation leading to smaller drops).

◆ Equipment adjustments

- Adjust nozzle to avoid a fogging or misting spray.
- Use low spray pressures.
- Keep distance from nozzle to target plant short.

herbicides, drift and cause damage to economically or aesthetically important plants. In all cases, there will be an added expense to applying the pesticide. Spray drift can have serious consequences, such as human or animal poisoning, fish kills, ornamental or turf damage, etc.

Pesticides can move downwind to nontarget areas in two ways: through vapor drift and particle drift.

Vapor Drift

Vapor drift occurs when vapors produced after a pesticide application are carried out of the treated area. The process of vapor production, called volatilization, can occur up to several days after an application. Pesticide vapors may drift even farther than spray particles.

Although all sprayed pesticides may be susceptible to vapor drift, only a few pesticides volatilize to a significant degree. Traditionally, herbicides such as dicamba (used in Trimec) and 2,4-D ester have produced much of the reported vapor-drift injury. A very small amount of these herbicides can injure sensitive plants such as ornamentals, grapes, tomatoes, or soybeans. The pesticide label often indicates whether vapor drift is a significant concern. If there is potential for vapor drift, steps should be taken to avoid it—such as working the pesticide into the soil, avoiding applications during hot weather, or selecting a less volatile product.

Because more vapor is produced as the temperature rises, the labels of certain pesticides recommend not using the product during hot weather (for example, above 85°F). Because it is unusual during midsummer in Illinois to have several consecutive days below the critical temperature, the safe application of highly volatile products may be severely limited. As an alternative to a 2,4-D ester formulation, for example, it may be safer to use a 2,4-D amine formulation during warm weather because amines are less volatile.

Particle Drift

Particle drift is probably what most people think of when they think of drift. Particle drift is the movement of spray droplets and particles, usually by wind. Particle drift can occur during or after the application. Equipment factors such as nozzle type, size, pressure, and angle and height of release (how far away the spray has to go to reach the target) affect particle drift. The influence of each of these factors on droplet size definitely affects the likelihood of drift. Producing large spray droplets is one of the keys to reducing spray drift. By adjusting various nozzle factors, you can increase the number of large droplets and minimize the formation of small droplets.

Unfortunately, no one nozzle is capable of creating a single specific droplet size. During the spray process, spray droplets in a wide variety of sizes are created. Some drops produced are too small to be observed with the unaided human eye. The real drift issue arises from the portion of the spray cloud that is invisible but moves off-target. Depending on weather conditions, these particles can be displaced at considerable distances, and their movement is difficult to predict.

Weather conditions can have a major impact on the amount of off-target drift. Factors affecting drift include wind speed and direction, temperature, relative humidity, and atmospheric stability. Wind speed is usually the most critical factor of all meteorological conditions affecting drift. The greater the wind speed, the farther off target small droplets are carried. Determining the wind direction relative to sensitive plants is important in attempting to avoid damage from drift. The presence of sensitive vegetation downwind often is overlooked by applicators. Leaving a buffer zone at the downwind edge of a spray area greatly reduces the potential for damage to sensitive plants. After the wind dies down or changes direction, the buffer zone can be sprayed safely.

Be aware that drift potential may be high at low wind speeds; light winds (0 to 3 mph) tend to be unpredictable and variable in direction. Drift potential is lowest at wind speeds between 3 and 10 mph (gentle but steady breeze) blowing in a safe

direction away from sensitive areas. High temperature, low humidity, and no-wind situations where the spray just hangs in the air should be avoided. Spraying in the morning when the temperature is lower, the humidity higher, and with a gentle breeze avoids many drift problems.

Movement of Pesticides by Water

Contamination of water is a serious problem associated with pesticide use.

Pesticides that move with water out of the target area may enter groundwater or surface water. In some cases, this contamination makes the water unfit for drinking or drastically alters the aquatic ecosystem. Water can move pesticides out of the target area in several ways. Pesticide movement into surface water or other down-slope areas occurs through runoff or erosion, while movement into groundwater occurs through leaching and run-in.

Pesticides and Surface Water: Runoff and Erosion

Pesticides that move off the treated area by runoff or erosion are either dissolved in water or attached to sediment that erodes from the land. When runoff or erosion occurs, a pesticide associated with the moving water or soil may move downslope to bodies of water or soils where it may injure or contaminate plants and animals. An aquatic ecosystem is greatly affected by the quality of the water on which its existence depends. Surface water supplies 60 percent of the drinking water in Illinois. Many citizens draw drinking water from surface-water sources, and long-term health may be affected by the quality of the water.

Surface-water contamination can be reduced by following practices that reduce runoff and soil erosion:

- Leave an untreated vegetative filter strip between the treated area and desirable adjacent plants, ditches, ponds, and streams to collect any pesticide or sediment that moves downslope. A strip of turf 3 to 6 feet wide works very well.
- Do not spray if a heavy rain is expected. In some situations, it may be beneficial to irrigate the areas with a low volume of water after applying a soil herbicide to encourage its movement into the soil. These practices should minimize the amount of pesticide left on the surface and available to be carried off site if a heavy rain occurs.

Use safe handling procedures to assure mishandling of pesticides does not result in direct water contamination. Examples of safe handling practices include:

- Prevent back-siphoning of spray tanks and irrigation systems into wells or other bodies of water.
- Do not fill your sprayer in the same location each time, which may allow small spills to build up.

Read the pesticide label for any special precautions.

Pesticides and Groundwater: Run-in and Leaching

Pesticides break down much slower in groundwater than in surface water. Under the soil surface, pesticides are not readily exposed to oxygen, sunlight, and other factors that are needed for pesticide breakdown. Groundwater is often impossible to purify once it becomes contaminated; where purification is possible, it is extremely expensive.

Groundwater supplies 30 percent of the drinking water in Illinois, including most farmsteads and homes in rural Illinois. Water withdrawn from a contaminated well can expose humans to pesticides that may cause adverse health effects. Various types of wells can be found throughout the state, with some more vulnerable than others to contamination from normal pesticide use. The vulnerability of a well depends on its construction, the integrity of its surface and seal. The soil type, rock and other underlying material, and depth of the groundwater from which the well

◆ Additionally, protect nontarget species by

- Utilizing buffer zones.
- Waiting until conditions are right to apply the pesticide.

◆ How can you prevent surface-water contamination?

- Use filter strips.
- Delay applications if heavy rain is expected.
- Make sure hoses do not back-siphon.
- Change areas for handling pesticides periodically to prevent pesticide buildup.
- Check the label for special precautions.

◆ How can pesticides move into water?

- Surface water
Runoff
Erosion
- Groundwater
Leaching
Run-in

◆ Groundwater contamination occurs

- By run-in
Pesticide moves directly from soil surface to groundwater.
Occurs through sinkholes or improperly sealed wells.
Prevent by following the Department of Public Health's guidelines for wells.
- By leaching
Pesticide moves downward in the soil profile with percolating water.
Occurs mainly in sandy soils.
Particular problem with shallow wells.

withdraws water are also important. Pesticides contaminate groundwater through run-in or leaching processes.

Run-in allows pesticide to move directly from the soil surface to the groundwater below before it can be adsorbed onto soil particles or degraded by soil microbes. Run-in can occur through sinkholes or improperly sealed wells. Sinkholes sometimes occur in areas where the soil is underlain with fractured carbonate rock such as limestone or dolomite. This formation occurs in some areas of northwestern and southern Illinois.

Improperly sealed wells should be repaired to prevent contamination of groundwater. The Illinois Department of Public Health has guidelines you should follow in ensuring that your well is properly and adequately sealed. Advance approval of your intended amendments is required.

Leaching can contaminate the groundwater by moving pesticides downward in the soil profile with percolating water. Leaching, which occurs mainly in sandy, permeable soils, is of particular concern with shallow wells. Check the pesticide label for cautions, particularly if the pesticide will be applied where there is sandy soil with little organic matter.

Residue, Tolerance, and Harvest Interval

Residue is the amount of a pesticide or its breakdown products that remains in the soil or a treated crop after pesticide application. Some residual activity from pesticides may be desirable so that re-treatment is unnecessary, but you must weigh the benefits against the risks of having pesticides persist longer in the environment.

Tolerance is the amount of pesticide residue that legally can remain in a crop when it is harvested. When applying pesticides to food crops, read labels carefully. Pesticide labels give restrictions on rates and timings of applications that, if followed, allow enough time for the pesticide to break down before treated food or feed is harvested. The **harvest interval** is the amount of time required by law that you must wait before consuming products such as fruits or vegetables that were treated with pesticide. The United States Environmental Protection Agency (US EPA) sets tolerance levels based on studies proving the residues from a given pesticide will be gone or at a safe level by harvest. Harvest intervals were designed for everyone's safety. If a pesticide is applied to a fruit or vegetable not on the label, the only safe alternative is not to harvest the crop.

Protecting Nontarget Species

Fish and other aquatic species in ponds, lakes, and streams are affected and can be killed by insecticides, herbicides, and liquid fertilizers. A pesticide or other potentially hazardous substance that is applied to or that runs off or spills into a body of water can expose fish and other animals. In moving bodies of water, chemicals moving downstream can injure these species for long distances. Even if the pesticides used do not injure or kill fish species, they may contaminate them, making them unsafe for consumption. The label precautions warn of any potential threat to fish populations. You should read these statements thoroughly before purchasing any product for use near aquatic areas.

All bees, including honey bees and wild bees, are important beneficial insects. They pollinate fruit, vegetables, and other crops. A pesticide applied or allowed to drift onto blooming plants can be fatal to bees. Follow these guidelines to protect bees.

- Use a pesticide with low bee toxicity if bees are nearby. Generally, insecticides are more hazardous to bees than any other type of pesticide. The pesticide label tells you if the product is toxic to bees.
- Spray when the bees are not active, such as before dawn or after dusk or when temperatures are less than 55°F.

Additional information on bee safety is found in the environmental hazards section of pesticide labels.

Labels

The pesticide label is the information that is either provided with or printed directly on the container (Figure 2). It is a legal document; but do not let that intimidate you. Most labels are relatively easy to read and understand. It is helpful though when you know exactly where to look for needed information. Become familiar with the general layout of the label to make life easier, especially in the event of an accident or spill. Remember that if you have trouble understanding a label, you can always consult your local University of Illinois Extension office or the product manufacturer for help.

By law, pesticide labels must contain certain kinds of information. Pesticide applicators have the legal responsibility to read, understand, and follow the label directions. Quite often, pesticide applicators fail to take the time to read or follow the specified safety sections of a label. To protect yourself and the environment, read the label—it's the law! Know that the most valuable time spent in pest control is the time you take to read the label.

When Should You Read the Label?

Before you purchase a pesticide, you should read the label to make sure it is the best product for the job. Is the product labeled for control of your pest and labeled for the plant or site? What is the formulation? Different formulations require different methods of handling. Some products are ready to use, but some may require adding a carrier such as water. Granular formulations are applied in the dry form, as purchased. The label also tells you how to properly mix and store the pesticide. When you have used all the product, check the label again for proper disposal of empty containers. Because product labels change from time to time, it is important to use the label that came with the product. If you use up last year's product and buy more, it is good to check the new label for changes. Yes, this is a lot of work reading and rereading the label, but isn't your health and the protection of the environment worth it?

What Information Is Found on a Pesticide Label?

Directions for Use

Probably the most read section of the label is the directions for use. This section is categorized into subheadings by the various plants or areas for which the pesticide legally may be used. Under each subheading are the application rates for the target pests. Remember that although it is illegal to apply a higher rate, it is perfectly legal to apply a lower rate. Keep in mind, however, that lower rates can lead to reduced pest control. A product may be applied only to plants or sites specified on the label. Never use a pesticide purchased for field use on your garden unless the label says it can be applied directly to your specific garden crops. You can mix two or more pesticides only if the labels say they may be mixed. Follow label directions to ensure a compatible mixture.

Material Safety Data Sheets

Material safety data sheets (MSDSs) are available through dealers and other chemical distributors. Chemical manufacturers provide this product health and safety information to supplement the information on the label.

Human Pesticide Protection

Toxicity

The toxicity of a pesticide is its capacity to cause injury or death, that is, how poisonous it is. How toxic a pesticide is to humans is determined by testing the pesticide on several species of laboratory mammals, such as rats, mice, and rabbits. After

◆ **Your best protection is to read the label!**

◆ **Read the label before you**

- Buy.
- Mix.
- Apply.
- Store.
- Dispose.


<ul style="list-style-type: none"> • Common name of product (dimethoate). • Ingredients that are toxic to the pest. • Proper storage and disposal of product. • Precautions to take during and after use. • What to do in case of a medical emergency? 	<div style="text-align: center;">  CYGON[®] Garden Spray </div> <ul style="list-style-type: none"> • Kills Damaging Insects on Trees, Shrubs, Flowers and Vegetables. • See Right Side of this Panel for a List of Insects Killed. <p>ACTIVE INGREDIENTS: Dimethoate (0, 0-dimethyl S-[(N-methylcarbamoyl)methyl] phosphorodithioate)* 12.00% INERT INGREDIENTS: 88.00% * Contains 51.41% Xylene</p> <p>Keep out of reach of children</p> <p>WARNING See back panel for additional precautionary statements For Homeowner Use Only.</p> <p>STORAGE: Store in original container and place in a locked storage area. DISPOSAL: Do not reuse container. Wrap and put in trash.</p> <p>PRECAUTIONARY STATEMENTS HAZARDOUS TO HUMANS AND DOMESTIC ANIMALS WARNING: Harmful or fatal if swallowed, inhaled or absorbed through the skin. Avoid breathing of vapors or spray mist. Avoid contact with skin, eyes and clothing. Wash thoroughly after handling and before eating or smoking. Do not contaminate feed or food stuffs. Keep children and pets off treated areas until treated surfaces have dried completely. Food utensils such as teaspoons and measuring cups should not be used for food purposes after use with insecticides.</p> <p>PHYSICAL AND CHEMICAL HAZARDS DO NOT USE, POUR, SPILL OR STORE NEAR HEAT OR OPEN FLAME.</p> <p>PRECAUTIONARY STATEMENTS IF SWALLOWED - Call physician or Poison Control Center immediately. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person. IF INHALED - Remove victim to fresh air. Apply artificial respiration if indicated. IF ON SKIN - Remove contaminated clothing and wash affected areas with soap and water. IF IN EYES - Flush eyes with plenty of water for at least 15 minutes. Get medical attention. NOTE TO PHYSICIAN - This product may cause cholinesterase inhibition. Atropine is antidotal. 2-PAM may be effective as an adjunct to atropine.</p>	<ul style="list-style-type: none"> • Trade name of product (Cygon) and formulation. • What is the relative safety of this pesticide? <p>In order of low- to high toxicity, three signal words are used:</p> <ul style="list-style-type: none"> - Caution - Warning - Danger-Poison
<ul style="list-style-type: none"> • Are there any special environmental considerations (i.e., fish, birds, bees, groundwater contamination) that you should be aware of when using this pesticide? • What do you need to wear during application? • Legal procedures and uses for this product. - What crops/areas? - What rates? - When can you harvest? 	<p>ENVIRONMENTAL HAZARDS This product is toxic to fish, birds, and other wildlife. Birds feeding on treated areas may be killed. Do not apply directly to lakes, streams, or ponds. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water by cleaning of equipment or disposal of wastes. Apply the product only as specified on this label. This product is highly toxic to bees exposed to direct treatment or residues on plants. Protective information may be obtained from your Cooperative Agricultural Extension Service.</p> <p>THE FOLLOWING PROTECTIVE CLOTHING MUST BE WORN DURING APPLICATION:</p> <ol style="list-style-type: none"> Impermeable gloves (for example, rubber or plastic covered reinforced gloves). Boots or boot covers. Long-sleeved shirt and long pants. Wide-brimmed hat. <p>CYGON[®], is a registered trademark of American Cyanamid Co. Buyer assumes all risks of use, storage, and handling of this material not in strict accordance with directions given herewith.</p> <p>Distributed by American Brand Chemical Co. Bonham, Texas 75418 EPA Est. No. 7401-TX-1 EPA Reg. No. 7401-338-7879 30M-12-32J Net Contents One Pint</p> <p>DIRECTIONS FOR USE It is a violation of Federal law to use this product in a manner inconsistent with its labeling. AMERICAN BRAND CYGON GARDEN SPRAY is effective in killing insects on trees, shrubs, flowers, and vegetables. To apply - ... SEE OFFICIAL LABEL</p>	<ul style="list-style-type: none"> • Environmental Protection Agency (EPA) registration number.

Figure 2. Pesticide label.

several tests, an LD₅₀ is established, which is the lethal dose for 50 percent of a test population: in other words, how much pesticide it takes to kill the average mammal. The lower the LD₅₀, the smaller the number and the more poisonous the pesticide. Remember that LD₅₀ refers to a dose: The smaller the dose that kills, the more toxic the pesticide. LD₅₀ numbers are the milligrams of pesticide per kilogram of test animal body weight, so the numbers are applicable to both small and large animals, such as humans. A milligram is one millionth of a kilogram, thus these numbers are also parts per million. LC₅₀ refers to lethal concentration for 50 percent of a test population when considering the amount of pesticide in the air.

LD₅₀s are not put on a pesticide label, although they can be found on the material safety data sheet (MSDS), which may be available when you buy a pesticide. Instead of putting the LD₅₀ on the pesticide label, signal words are used instead (Table 4). Thus, the word "WARNING" tells you that the pesticide is more poisonous, and probably much more poisonous, than a pesticide labeled with the word "CAUTION."

Hazard

The hazard of a pesticide depends on a combination of toxicity and exposure. Wearing the proper clothing and other personal protective equipment helps reduce the body's exposure to the pesticide, thus reducing the hazard. A person applying a pesticide with relatively low toxicity while wearing shorts, a tank top, and no hat or socks may be in a more hazardous situation than one applying a more toxic pesticide while wearing protective clothing. The increased amount of exposure greatly increases the hazard of the situation—much more than is necessary.

Hazard = Toxicity + Exposure

Entry into Treated Areas

Some pesticides state on the label how soon you can enter an area after it has been treated. This period likely is given as a reentry time or restricted-entry interval. If there is no reentry time on the label, legally you should not reenter the area until the spray has dried or the dust has settled from the application. However, recent research and rules and regulations indicate that staying out of a treated area for 24 hours may be appropriate. If you need to enter the area earlier, wear the same protective clothing that is recommended while applying the pesticide.

Exposure

You can be poisoned by pesticides by swallowing them, breathing them in, or getting them on your skin. Oral exposure occurs by accidentally eating or drinking the pesticide, which can occur by not washing before eating or not noticing what you drink. (This is the most common way that children are poisoned.) To prevent accidental oral exposure, keep pesticides locked up; never leave an area where a pesticide is sitting on a bench or counter; and never store pesticides in a beverage bottle or anything that might look like one.

Inhalation exposure can happen by breathing in pesticide dust while filling the fertilizer spreader with weed and feed, grub insecticide, or other pesticide. Filling the sprayer in a basement or closed garage may allow pesticide fumes to build up

◆ What do the signal words mean?

DANGER–POISON:

highly poisonous

DANGER:

poisonous or corrosive

WARNING:

moderately hazardous

CAUTION:

least hazardous

TABLE 4. Pesticide Label Signal Words

Toxicity	Signal word	Oral LD ₅₀	Dermal LD ₅₀	Inhalation LC ₅₀
High	Danger–Poison	0–50	0–200	0–2,000
Moderate	Warning	50–500	200–2,000	2,000–20,000
Low	Caution	500–5,000	2,000–20,000	20,000+
Very low	Caution	5,000+	20,000+	–

◆ Pesticide poisoning symptoms

Light poisoning	Severe poisoning
Fatigue	Excessive sweating
Headache	Stomach cramps
Nausea	Vomiting
Dizziness	Diarrhea
	Blurred vision

◆ Treatment of poisoning

- Give first aid.
- Contact a doctor immediately.
- Tell what pesticide was used.
- Take pesticide label along if medical care is needed.

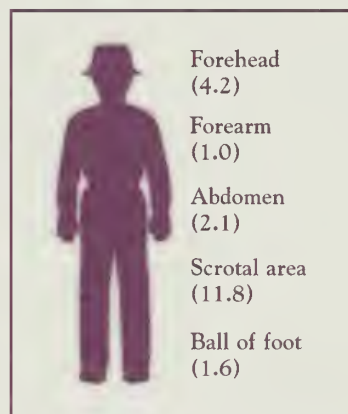


Figure 3. Rate of dermal pesticide absorption

◆ First aid for pesticide poisoning

- **Oral:** Drink at least one quart of milk or water.
- **Dermal:** Wash with soap and water; remove affected clothing.
- **Eye:** Flush eyeball with running water for at least 15 minutes.
- **Inhalation:** Get into fresh air, loosen tight collar.

and be inhaled. Smoking without washing your hands is another way to be poisoned by breathing in the pesticide.

Dermal exposure occurs when pesticide comes into contact with your skin. You may spill pesticide concentrate on yourself while filling the sprayer. The hose may pop off the sprayer or split while pressurizing the sprayer. Spray mixture may run out onto your hand and arm from leakage around the sprayer trigger, or spray drift may blow back into your face from a wind shift. Wearing proper protective clothing and equipment helps reduce most dermal exposure.

Some areas of your skin absorb pesticides more quickly than other areas. (Figure 3) These sensitive areas are those where many blood vessels are close to the skin's surface. Always wear a hat while applying pesticides to reduce absorption through the top of the head and forehead. This area absorbs pesticide 4.2 times faster than the forearm. Wear a repellent apron while filling the sprayer to protect the groin area from pesticide splashes. For this area, the rate is 11.8 times faster than the forearm.

Poisoning Symptoms and Treatment

Most pesticide poisoning causes similar symptoms, which tend to feel much like those of the flu or being drunk. Mild symptoms include tiredness, headache, nausea, and dizziness. More severe symptoms include breaking out into a heavy sweat, stomach cramps, vomiting, diarrhea, and blurred vision. If not treated, heavy poisoning can result in unconsciousness, coma, and death.

If pesticide poisoning occurs, administer first aid and immediately contact a physician. Have the pesticide container or label when you call so that you can tell the physician what pesticide was being used. If medical treatment is needed, take the pesticide label with you because most labels provide notes to the physician on the proper treatment of poisoning. Having the label also allows the physician to verify which pesticide was being used.

First-aid efforts can greatly reduce the harmful effects of pesticide exposure and assist medical treatment. Dilute swallowed pesticides by drinking at least a quart of milk or water. The calcium in milk helps neutralize many pesticides and protect the throat and stomach linings. Skim, whole, or canned milk is equally effective. Do not induce vomiting unless directed by the physician or the pesticide label. Some pesticides, particularly herbicides, are corrosive and may cause additional damage to the linings of the throat and mouth when vomited.

Pesticide on the skin should be washed off immediately. Soap and water are best, but water alone is better than nothing. Because this use is external, water in mud puddles can be used if clean water is not nearby. Remove any pesticide-soaked clothing and wash the contaminated skin underneath. The length of time that the pesticide is in contact with the skin is very important, so delaying even a few seconds can be critical.

Pesticide in the eyes should be flushed with running water for 15 minutes. This treatment requires a large source of water. When mixing and using pesticides, determine beforehand where the nearest hose or faucet is located. If an outdoor faucet is needed, make sure that it has not been turned off indoors and that it has a handle. For inhaled pesticide, get the person into fresh air and loosen any tight clothing that may restrict breathing.

Additional information on treatment of pesticide poisoning can be obtained 24 hours a day from the Illinois Poison Resource Center, (800)942-5969. The pesticide label also may give an emergency phone number. The National Pesticide Telecommunications Network at (800)858-7378 provides quality information about specific pesticides, as well as poisoning-treatment information.

Protective Clothing and Equipment

When applying granular or dilute liquid pesticides, limit the amount of skin exposure. Wear a long-sleeved shirt, long pants, and shoes and socks that protect most

of your body. Wear a hat to reduce absorption through the top of your head and forehead. Your hands are most likely to become exposed to pesticides, so protect them with unlined chemical-resistant gloves.

Clothing with a high cotton content absorbs small amounts of pesticide and protects your skin. Coveralls made of a spun-bonded olefin fabric such as Tyvek™ have the advantage of being inexpensive enough to throw away when soiled with pesticides. Gloves should be made of nitrile, neoprene, butyl rubber, or other chemical-resistant material. Although a thin, sprayed flocking lining is acceptable, thicker glove linings can absorb pesticide, causing direct, long-term contact with your hands.

Wear additional protective clothing and equipment when handling pesticide concentrates, mixing pesticides, and filling the sprayer. Wear goggles to protect your eyes from splashes and pesticide dust. Wear a chemical-resistant apron to protect the groin area from splashes or spills down the front of your body. Wear chemical-resistant boots for additional foot protection. Use a respirator if one is recommended on the pesticide label. Immediately after use, wash gloves, goggles, and other protective equipment with soap and water.

Laundering Contaminated Clothing

If left in the clothing, residues from even minor pesticide deposits or from dust or spray-drift accumulation can eventually contaminate the wearer. Therefore, clothing should be laundered daily, including your hat. More pesticide residue is removed when garments are laundered within 8 hours after use than if allowed to sit for a longer period. Wear a clean set of clothing each day.

Normal laundering and a few simple precautions adequately remove pesticide residues from clothing. Follow the steps listed. Assume that all clothing worn while handling or applying pesticides is contaminated. Starching clothes makes it more likely that pesticides are shed off the garment rather than soaking in. Much of the pesticide that stays on the clothes is taken up by the starch. When the clothes are washed, the pesticides are washed away with the starch.

If clothes become contaminated with liquid pesticide concentrates, they should be thrown away. Even with proper laundering, enough residue can remain in the fabric to be absorbed through the skin. Soiled Tyvek™ and other spun-bonded olefin clothing should be thrown away because washing reduces their protective quality.

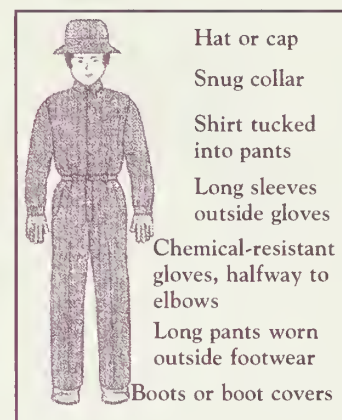
Handling Pesticides

When transporting pesticides, do not place them near any groceries, pet food, or other food. Haul pesticides in the back of a pickup or in the trunk to reduce the likelihood of fumes from the pesticides being breathed by people.

Mix pesticides and fill the sprayer or spreader in an open area where ventilation is good. Mixing on the driveway is preferable to mixing in the garage or shed. When pouring any concentrated pesticide from the container, keep the container below eye level to avoid a splash or spill onto yourself. Measure the pesticide in clean containers that you label and use only for pesticides. Thoroughly wash these containers after use. Open containers of pesticide concentrates carefully. Cut bags and other paper pesticide containers with scissors rather than tearing them and causing dust to fly onto your face. Always stand upwind when mixing pesticides.

When filling sprayers, don't put the end of the hose down into the liquid in the sprayer tank. Not only does this keep the end of the hose from being contaminated, but the air gap between the hose and spray liquid prevents back-siphoning. If the end of the hose is down in the spray mixture, it can create a siphon and the mixture can flow back into your water source. Although primarily a problem when using a well, back-siphoning into municipal water supplies has occurred.

Before applying pesticides, pick up any toys, bicycles, or other child belongings in the area to keep them from being contaminated by spray drift. Don't apply pesticides if children are nearby. Applying pesticides in the early morning hours before

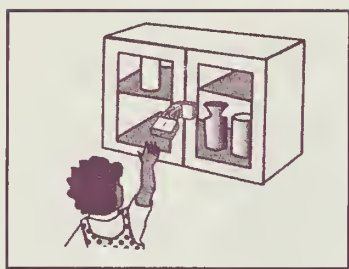


◆ Washing contaminated clothing

- Launder as a separate load.
- Handle with chemical-resistant gloves.
- Use hot-water wash, cold-water rinse, heavy-duty laundry detergent.
- Clean washer by running a complete cycle with detergent and hot water without clothing.
- Line dry—if practical.

◆ Protect others from pesticide

- Remove toys and bicycles from the area to be treated.
- Apply when children are not present.
- Avoid the treated area for at least 24 hours.
- Be especially watchful of bare-foot children.



◆ Triple-rinsing of pesticide containers

- Drain container for 30 seconds into sprayer.
- Refill container $\frac{1}{5}$ to $\frac{1}{4}$ full of rinse water.
- Replace cap, rinse thoroughly, pour in sprayer, and drain for 30 seconds.
- Repeat steps 2 and 3 two more times.

children get out of bed is effective. Although it is a good idea to avoid treated areas for 24 hours after treatment, be especially watchful of toddlers and other children contacting treated areas while barefoot and wearing only diapers or shorts. Once you finish applying pesticides, shower and put on a fresh set of clothes so that pesticide residue doesn't remain against your skin any longer than necessary.

Storage

Store pesticides in a separate cabinet. Do not store anything else (such as fertilizer, paint, gloves, or tools) with the pesticides because pesticide fumes can contaminate other materials. In fact, store your herbicides separately from insecticides, fungicides, and other pesticides because the fumes from herbicides can contaminate other pesticides. Keep the pesticide cabinet locked and labeled. Keep the cabinet locked even when you are using a pesticide. Children have gotten into pesticides and have been poisoned while the gardener was called away to the phone.

The storage area should be located in an area where the pesticides neither freeze nor get too hot but are well ventilated. Many pesticides break down and lose their effectiveness if the temperature gets much above 100°F. The components of some pesticides separate if they freeze. Many garages are good storage areas.

Nearby and handy to the storage area should be a source of water, soap, fire extinguisher, broom, dustpan, trash can, and pesticide-absorbent material such as sawdust, kitty litter, or oil-dry. These materials will be needed quickly in case there is a spill or fire.

Try to keep your storage needs to a minimum. When you buy a pesticide, get only the amount needed for the pest situation or for the current gardening season. Even though small bottles and other containers are more expensive per ounce, you reduce the likelihood of having old pesticides that you have no use for. If stored properly, most pesticides retain their effectiveness for 5 years; but some, particularly those that are organically based, may not be effective that long.

If a pesticide container breaks or starts leaking, the best option is to use the pesticide. Pesticide can be placed in a similar container, provided that the label from the old container is put on the new one. If the pesticide was in a brown glass bottle, put it in another brown glass bottle. If it was in a heavy paper bag, use another heavy paper bag. Never use a beverage bottle or other container that a child or adult could confuse for a food or drink container. Such substitutions cause many child poisonings. If you can't get the label off the old bottle, get a replacement label by contacting the store where you bought the pesticide; or call the pesticide company's phone number, which should be on the label. You can also obtain many pesticide labels over the Internet.

Disposal

Use any mixed pesticide the day you mix it. Pesticide mixed with water and kept overnight in the sprayer loses much of its ability to control pests by the next day. For the same reason, don't mix up "stock" solutions of pesticide for further diluting and using through the growing season.

Avoid excess mixed pesticide by planning carefully how much pesticide is needed. If it's difficult to estimate the amount needed, such as spraying a large shrub to runoff, mix up the least amount that you think you need, and then mix up some more, if necessary, to finish the job. Excess mixed pesticide should be applied to an area listed on the label, whether the pest is present or not. The same should be done with rinse water from cleaning out the sprayer or spreader. Do not spray it over the area that you treated if the addition of the original application and the rinsate exceeds the maximum labeled rate. Find another site that is listed on the label.

Pesticide concentrate that you no longer have any use for should be taken to a household hazardous-waste collection site for disposal. Consult the Illinois Environmental Protection Agency Web site at <http://www.epa.state.il.us/> for the

location and times of permanent sites and one-day collections. Small quantities of excess pesticide, such as those purchased by gardeners, can be disposed of by wrapping the container in several layers of newspapers, enclosing it inside a labeled plastic bag, and putting it with your household trash for pickup. This way, your pesticide ends up in a local landfill. It is preferable, however, to take the pesticide to a household hazardous-waste collection site so that it is handled in a more environmentally proper manner.

When emptying a pesticide container, clean it properly for disposal. Paper bags, cardboard cans, and other paper containers should be tapped gently to shake loose any remaining pesticide. Bottles, jugs, and metal cans should be triple-rinsed as described in the sidebar. Properly cleaned containers should be placed in the household trash for normal trash collection. Dispose of pesticide-contaminated clothing or personal protective equipment by wrapping in several layers of newspaper, enclosing in a labeled plastic bag, and placing in the household trash for collection.

Understanding Pesticides

A pesticide is any chemical used to destroy, prevent, or control any form of life declared to be a pest. In the word *pesticide*, the prefix *pest* refers to a plant, insect, disease, animal, or other unwanted pest. The suffix *cide* means “to kill.” As you can see in the sidebar, many specific groups of pesticides are available. Although attractants, repellents, and growth regulators may only modify pest behavior or growth, they are useful in pest management and classified as pesticides by the US EPA.

Ingredients

When you purchase a pesticide, you are buying two general types of ingredients—active and inert. An active ingredient is the part of the formulation that is effective against the targeted pest, whereas inert (or other) ingredients do not have a direct effect on the pest. The pesticide manufacturer adds inert ingredients to make the product more effective. For example, some inert ingredients may allow the active ingredient to be mixed thoroughly with the water carrier, while others may improve application coverage on the target area or pest. In some cases, inert ingredients are added to improve storage or to make the product safer for the applicator or the environment. The US EPA continually evaluates active and inert ingredients to ensure human and environmental safety.

Pesticide Characteristics

Selectivity

It is important to understand that not all pesticides within a particular pesticide group work the same way. For example, the herbicide active ingredient glyphosate (found in Roundup) works quite well to control broadleaf weeds in the lawn, but it also kills the desirable turf. It is an example of a nonselective herbicide, meaning it controls virtually all plant types. Using such a product would be appropriate if one were renovating a lawn. On the other hand, using a selective herbicide active ingredient such as 2,4-D or dicamba would be entirely appropriate when you want to control only the broadleaf weeds. The terms *selective* and *nonselective* apply to other pesticide groups as well; be sure to read the pesticide label to identify which pests and nonpests will be affected by the pesticide application. For example, the active ingredient carbaryl (found in Sevin) kills the cucumber beetle insect pest as well as beneficial bees and lady beetles. Keep in mind that selectivity may be affected by the rate used, meaning that a very high rate may kill or injure even tolerant plants or other organisms.

Mobility

Besides selectivity, there are some other terms you should know when choosing a pesticide. Pesticide labels often indicate that the product has either systemic or

Pesticide group	Target pest(s)
acaricide (miticide)	mites, ticks
attractant	insects, birds
bactericide	bacteria
fungicide	fungi
growth regulator	insects, plants
herbicide	plants
insecticide	insects
molluscicide	snails, slugs
nematicide	nematodes
piscicide	fish
repellent	insects, vertebrates
rodenticide	rodents

contact activity. Systemic (or translocated) pesticides move within the plant or animal from the site of uptake to other parts of the plant or animal. (Figure 4) Systemic fungicides and insecticides enter the plant or animal and kill the pest without harming the host plant or animal. Systemic insecticides are particularly useful against insects with piercing-sucking mouthparts. A systemic herbicide is useful for controlling perennial weeds because the herbicide can move into, and kill, underground root structures.

Not all systemic pesticides move throughout the entire plant, so it is still important to read the label for product limitations and to apply the product thoroughly, as directed by the label. For example, systemic herbicides may be most effective when applied in the fall because this is when the plant replenishes the carbohydrate supply to the root structures. Also, application of a systemic fungicide to the upper leaves does not provide disease control for the entire plant.

Contact pesticides control by direct contact with the pest. Contact fungicides kill or inhibit the fungus before it enters the plant. Contact insecticides enter the insect when it eats treated leaves or may be absorbed through the insect's cuticle (outer "skin") when it comes in contact with the insecticide. Contact herbicides kill only the plant tissue they contact. They are generally effective at controlling small annual weeds but are less effective on perennials because they do not kill the root system.

Because contact pesticides do not move in the plant, thorough spray coverage is needed for effective control. For example, a contact fungicide such as mancozeb protects only the areas of the plant that were sprayed—spotty coverage results in poor or no control. In addition, because contact pesticides remain on the plant's outside, they may wash off or break down quickly, requiring frequent reapplications.

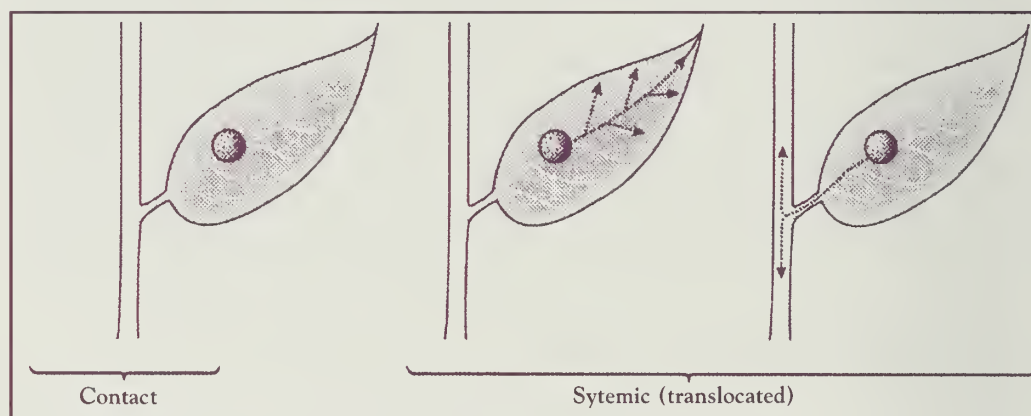


Figure 4. Mobility of pesticides.

Timing, Timing, Timing

Pesticides may be applied at different times, depending on the pest to be controlled and how the pesticide works. Although some pesticides may require only one timely application for season-long control, you may need to apply others more than once at proper intervals to control pests. For example, crabgrass- and grub-control products, when properly applied to the lawn, need be applied only once during the growing season. On the other hand, the fungicides used to control crabapple scab and rose black spot likely require repeated applications. *Always read the pesticide label for specific directions on proper timing of pesticide applications.*

Some common terms are used to describe the application timing of herbicides. For example, a "crabgrass preventer" is a *preemergence* herbicide that must be applied before the crabgrass seedlings emerge. Preemergence herbicides work by stopping seed germination or seedling emergence but have little or no effect on established or transplanted plants. The label indicates how long you must wait before trying to plant desirable seeds into the treated area. *Postemergence* herbicides are applied after the weeds emerge and have virtually no effect on ungerminated seeds.

Avoiding Problems

Besides factors such as selectivity, mobility, timing, and application technique, there are other reasons why a pesticide application might fail to control the pest or cause unexpected plant damage.

- Prolonged periods of hot, dry weather may reduce the effectiveness of post-emergence herbicides. In general, postemergence herbicides are most effective when applied to actively growing weeds.
- Rainfall soon after a foliar application may simply wash the pesticide off the foliage, rendering it ineffective. As a general rule, there should be 4 hours between the application and the next rain.
- Heavy rainfall soon after the application of granular products can wash the pesticide out of the target area, which may reduce activity and result in environmental damage. Some labels suggest irrigation before and/or after application to help incorporate the product into the soil.
- The activity of some pesticides, particularly insecticides, may be reduced when mixed with high-pH water. Where this is a concern, the pesticide may contain a pH buffer or indicate that the spray should be used immediately after mixing with water.

Pesticide Formulations

Pesticides may be purchased as a dry powder, granule, liquid, or slurry formulation. Some formulations are ready to use as is, while others may require dilution with water or some other carrier.

Although details of product formulation are seldom given on pesticides labeled for homeowner use, the manufacturer provides important instructions on the label that enable the user to use the product safely and accurately. For example, if a product forms a suspension in water, it has a tendency to settle out, so the label instructs the user to “mix thoroughly, agitate frequently, and do not allow the mixture to stand overnight.” For a dry formulation, the label may require the user to avoid mixing or using the product in enclosed areas and perhaps to wear personal protective equipment to protect against inhaling the product. As a matter of safety, the most difficult formulations and dangerous products are available only to trained and certified pesticide applicators. When the type of formulation is disclosed, refer to Table 5 for details and additional comments.

Certain pesticide mixtures and the use of certain adjuvants can increase the effectiveness of the application. For that very reason, pesticide formulations may include more than one type of active ingredient or may include adjuvants such as spreaders–stickers that increase coverage, increase penetration, or help the pesticide stick to the treated surface better. However, mixing certain formulations, active ingredients, and adjuvants can cause compatibility problems that may result in wasted product and damage to desirable plants. Never assume that it is safe to “brew your own” pesticide mixture. If the product labels do not address the mixture you wish to make, contact the manufacturer for advice.

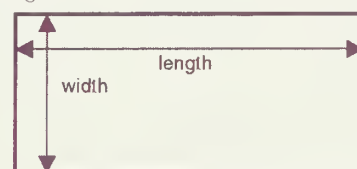
Application Equipment and Calibration

Many different types of equipment may be used in applying pesticides around the yard and garden. When it comes to ease of use, accuracy, and maintenance, each piece of equipment has its pros and cons. These issues are discussed in Table 6. As the calibration issues are addressed below, refer to the sideboxes as a refresher on how to measure land areas accurately.

Spot and Selective Applications

There is a variety of application techniques and tools on the market that can be used to apply pesticides in a very precise manner. Many manufacturers now sell prediluted, or ready-to-use (RTU), formulations in disposable containers. These containers may

Rectangular areas



A lawn area measures 75 feet long by 40 feet wide. What is the area?

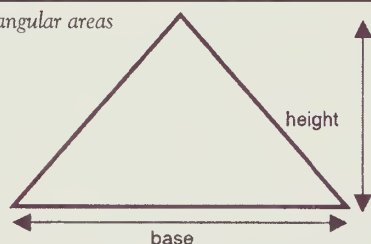
Area = length x width

Area = 75 x 40 = 3,000 sq ft

TABLE 5. Pesticide Formulations

Formulation and label abbreviations	Comments
Dry formulations	
SP (soluble powder)	Mix with water carrier (needs initial, light agitation). If inhaled, dust may cause harm.
WP (wetable powder)	Mix with water carrier (needs frequent, strong agitation).
WDG (water-dispersible granule)	If inhaled, dust may cause harm.
DF (dry flowable)	
D (dusts)	No mixing required—applied as is. Fine dust that easily moves off target and can cause harm.
G (granule)	No mixing required—applied as is. Often requires rainfall or irrigation to be effective.
P (pellets)	No mixing required—applied as is. Larger than granules. Use only where inaccessible to children and pets.
Liquid formulations	
E, EC (emulsifiable concentrate)	Mix with water carrier (intermittent, light agitation). Can injure desirable plants. Oil solvent is easily absorbed into skin, may be corrosive to finished surfaces, and may degrade rubber products such as gloves and sprayer-pump parts.
F (flowable), L (liquid)	Mix with water carrier (frequent, moderate agitation).
S (solution)	Mix with water carrier (initial, light agitation).
A (aerosol)	No mixing required; product is stored under pressure. Mist or smoke is easily inhaled and can cause harm. Gas propellant may be flammable.

Triangular areas



The corner of a lawn has a base of 250 feet and a height of 50 feet. What is the area?

$$\text{Area} = \frac{\text{base} \times \text{height}}{2}$$

$$\text{Area} = \frac{250 \times 50}{2} = 6,250 \text{ sq ft}$$

be plastic (similar to window-cleaner spray bottles), or they may be pressurized metal cans that contain a liquid or aerosol. As one example, the nonselective herbicide, glyphosate (Roundup), is available as a foam that can be sprayed from a disposable plastic container onto individual weeds without concern for pesticide drift. Weeds also can be spot-treated using a sponge, brush, or wand soaked with dilute herbicide. In addition, some specialized techniques used by professional applicators allow direct injection of insecticides, fungicides, or nutrients into landscape trees.

Although these techniques are time-consuming (particularly when large numbers of plants must be treated), in terms of pesticide use, there are many potential benefits, including

- reduced exposure to humans and pets
- reduced off-target movement
- reduced injury to adjacent desirable plants
- reduced pesticide waste.

Hose-End Sprayers

These sprayers attach to the end of a garden hose, and the liquid concentrate is metered from the container into the hose-supplied water by a siphoning action. Hose-end sprayers are best suited for applying pesticides, such as postemergence

TABLE 6. Tank Sprayers

Feature	Spray bottle	Compressed-air	Backpack	Boom
Cost	less than \$5	\$20–50	\$80–125	\$150 and up
Suitability	spot applications	small jobs	medium jobs	large jobs
Tank capacity	usually 1 quart	1–5 gallons	3–6 gallons	5 gallons or more
Operation	squeeze trigger	hand-operated air pump	hand-operated piston or diaphragm pump	engine or wheel-driven pump
Agitation	manual shaking	manual shaking	varies—pump may provide some agitation	varies—pump may provide some agitation
Notes	Adjustable nozzle provides anything from a stream to a fine mist. Fine droplets provide excellent coverage. Because there is no hose or wand, the potential for user exposure to the pesticide may be higher compared to other types of liquid applications.	Vary considerably in quality of construction. May be difficult to maintain consistent pressure, so the application may not be uniform—not ideal for broadcast applications. Difficult to operate pump while walking. Consider buying the more expensive backpack sprayer if you plan to <ul style="list-style-type: none"> • spray often, • broadcast spray, or • use contact pesticides. 	Easy to use and maintains fairly consistent pressure (may include pressure gauge). Using a fine drop size nozzle, this type of sprayer can provide the coverage required for contact pesticides. However, use of fine nozzles and high pressure increases potential for drift.	Features are similar to the backpack sprayer, but it requires a riding lawn mower or similar motorized vehicle. May provide the most even application. Wheel-driven pumps operate under low pressure and should not be used with contact pesticides.

broadleaf herbicides, that do not require thorough coverage. These sprayers are available as either

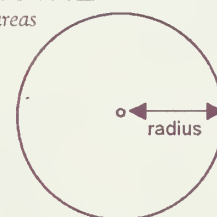
Single-use container. You must purchase the pesticide in prepackaged, disposable containers. There is no adjustable metering device as on the reusable applicator, and there is no need to measure pesticide into the container.

Reusable container. Both the sprayer and jar can be used, and reused, with your choice of pesticide. Unless it has been diluted or contaminated by the previously used pesticide, excess pesticide can be poured back into its original container for future use. To calibrate, follow the sprayer instructions, or see the sidebar.

Although “thick liquid” (for example, F or L) and some dry (for example, SP or WP) pesticide formulations can be diluted with water and applied using this type of sprayer, the practice is not recommended for the following reasons:

- These formulations often form a suspension of particles that may not siphon well and may even clog the sprayer. Unless you pay close attention, you may not notice these problems.
- Unless the sprayer manufacturer or product label provides specific dilution instructions, you may find the dilution calculations to be difficult. Given the limited tank size and dial settings, you may not be able to dilute the product enough to obtain the required waterlike consistency.

Circular areas



$$\text{Area} = \pi r^2$$

$$\pi = 3.14$$

$$r = \text{radius } (\frac{1}{2} \text{ the diameter})$$

A circular area has a diameter of 20 feet. What is the area?

$$\begin{aligned} \text{Area} &= 3.14 \times 10^2 \\ &= 3.14 \times 100 \\ &= 314 \text{ sq ft} \end{aligned}$$

◆ Hose-end sprayer calibration

1. Measure the area (sq ft) to be treated.
2. Set the meter dial to the rate per gallon (tsp/gal, or fl oz/gal) as directed by the pesticide label and sprayer instructions.
3. Determine how much pesticide formulation will be needed for the measured area and add it to the jar. Don't add water unless dilution is needed.
4. Spray evenly over the measured area until the jar is empty

Note: Even application is essential.

Before applying the pesticide, be sure to practice your application pace over the measured area using water (same amount as determined in step 3) in the jar instead of pesticide.

◆ Point of runoff

- Direct the spray to all parts of the plant until it begins to drip from the leaves and stems.

Note: A plant in full leaf will take more spray than the same plant early in the spring.

◆ Measuring tips

Measuring tools used for pesticides should never be used for anything else.

- 128 fl oz = 1 gallon
- 8 fl oz = 1 cup
- 1 fl oz = 2 tablespoons
- 1 Tbsp = 3 teaspoons

◆ Clogged nozzle?

Even fine wire can damage the nozzle output and spray pattern. Use a designated toothbrush to clean the nozzle orifice. Never use your mouth to blow out a clogged nozzle.

Tank Sprayers

Tank sprayers include simple spray bottles (similar to those that window cleaner comes in), compressed-air sprayers, backpack pump sprayers, and boom sprayers. In contrast to hose-end sprayers, a tank sprayer must contain a very dilute liquid mixture of water and pesticide. Regardless of which tank sprayer you choose, calibration is essential. See the following discussion and examples for help in calibrating your sprayer. To learn more about spray equipment and how to calibrate boom sprayers, read *Illinois Pesticide Applicator Training Manual 39-1 (Turfgrass)* or *39-3 (Ornamentals)*. Both are available through your local Extension office or the University of Illinois, ITCS Marketing and Distribution, 1917 S. Wright St., Champaign, Illinois 61820, or (800)345-6087.

Spraying flowers, bushes, and small shrubs and trees. Here are some examples of application instructions taken from actual pesticide labels:

"... mix 4½ level tablespoons of this product with two gallons of water and spray to thoroughly cover upper and lower sides of plant foliage."

"Use 1 fl oz per gallon of water. Apply to the point of runoff."

Example 1

You want to apply a fungicide to eight rose bushes to manage black spot. The fungicide label instructs you to use 1 fluid ounce of product per gallon of water and apply to the point of runoff.

You may ask, "How many gallons of spray do I need to prepare?" To answer this question, fill your (clean) sprayer with a measured amount of plain water and then spray one or more representative plants to the point of runoff. Determine how many gallons it takes per plant, and then multiply that number by the number of plants you want to spray. Now you know how many gallons of spray you need to do the job. In this case, let's say a rose bush takes 4 fluid ounces of water. So, 4 fluid ounces times eight rose bushes equals 32 fluid ounces. You need 1 quart of spray.

Okay, so you need 1 quart of water, but how much product do you add to the tank? Because the recommendation says 1 fluid ounce of product per gallon, you have some quick math to complete. For this example, all you need to do is realize that 32 fluid ounces is 25 percent ($\frac{32}{128}$) of one gallon, so 25 percent of 1 fluid ounce is ¼ fluid ounce. Answer? Add ¼ fluid ounce (or 1.5 teaspoons) of product and 32 fluid ounces of water to the tank, mix, and spray each rose bush to the point of runoff. *Note:* Without specialized application equipment, it is difficult to apply the spray uniformly to all surfaces of large shrubs and trees. Consider hiring a professional applicator who has the experience and the equipment for such jobs.

Spraying lawn and garden bed areas. Once again, here are some examples of pesticide application instructions taken from actual pesticide labels:

"... apply 2 oz of this product to 1,000 sq ft. Use a sufficient amount of water to obtain thorough coverage (2–5 gallons per 1,000 sq ft)."

"Use 7 fl. oz per gallon to treat 500 sq ft."

Example 2

An herbicide label instructs you to apply 4 fluid ounces of product per gallon of water to 1,000 square feet to control existing lawn weeds. This means that for each 1,000 square feet of lawn area to be treated, you need to add 4 fluid ounces of pesticide and 1 gallon of water to the tank. How can you be sure that you apply 1 gallon of spray per 1,000 square feet? First, refer to the area calculations in the sidebars on the previous pages as a refresher on how to measure land areas accurately. Second, follow the steps below to practice your application technique and pace.

Step 1: Practice your technique. Measure and mark off a 1,000 square foot (for example, 20 feet by 50 feet) practice area similar to the actual application site. If you are unfamiliar with the sprayer, take a few minutes to practice spraying the area with water. When spraying, maintain a constant walking speed and nozzle height

while sweeping the wand side to side in a swath 3 to 4 feet wide. To obtain uniform application, use the 100 percent overlap method described in the sidebar. Practice maintaining consistent pressure by periodically pumping the sprayer. If you do not have a pressure gauge, you can judge pressure changes by observing the spray pattern coming out of the nozzle.

Step 2: Practice your pace. Once you have developed a feel for the sprayer and have developed a consistent technique, the next step is to develop a pace that delivers the appropriate amount of spray per 1,000 square feet. To do this, add a measured amount of water to the tank; spray the area as you did earlier (remember to use the 100 percent overlap method again); then measure the amount of water remaining in the tank. The difference in the tank before and after spraying is the amount used. For example, 2 gallons added to the tank, minus 1 gallon remaining, equals 1 gallon used per 1,000 square feet. Thus, your spray application rate for the above conditions is 1 gallon per 1,000 square feet. If you applied more than 1 gallon, speed up next time. If you applied less than 1 gallon, slow down. Once you feel comfortable with your accuracy, proceed with the real application.

Cleanup and storage. Once you have mixed pesticide and water, you must use it—never store it for later use. If you have leftover spray, it is best to apply it to another labeled site. Ask your neighbors if they have an appropriate site to which the excess pesticide could be applied. In such cases, keep in mind that you can legally spray a labeled site even when the pest is not present. See “Disposal” for more information.

To extend the useful life of your sprayer and to prevent contamination of future applications, clean your sprayer and formulation-measuring device immediately after each use and when changing pesticides. For example, if you apply a herbicide to the lawn and then sometime later use the same sprayer to apply an insecticide to your rose bushes, even a very small amount of herbicide residue left in the tank, hose, or pump can cause substantial damage to the roses.

No cleaning method is 100 percent effective, so you may want to consider owning two sprayers—one for herbicides only and one for insecticides and fungicides. Many pesticide labels provide instructions for cleaning the sprayer. When label instructions are inadequate, or not given, follow the instructions in the sidebar.

After cleaning the sprayer, operate it to remove excess water from the tank, pump, and hose. Remove the tank cap and store the sprayer upside down to dry.

Granular Applicators

Many herbicides and insecticides are available in granular form for the lawn and garden. In addition, many manufacturers conveniently offer lawn-fertilizer products that contain insecticides or preemergence herbicides.

There are a number of ways to apply granular materials, including handheld shaker cans, ground-driven drop spreaders, and handheld or ground-driven rotary (Figure 5) (centrifugal) spreaders (Figure 6). Table 7 summarizes the pros and cons of each system.

It is important to apply granules uniformly on turf because even small differences in application rate can result in obvious fertilizer streaks and skips in pest control. Here are some tips to help improve uniformity of application:

- Store granules in a dry, safe place.
- Calibrate your spreader as described below.
- Walk at a constant pace.
- Create header strips to use for turning around.
- Shut off the spreader while turning in header strips.
- Reduce spreader output by half and use the 100 percent–overlap (half-swath) application method.

For a detailed discussion on how to check the distribution pattern of a rotary spreader, refer to *Illinois Pesticide Applicator Training Manual 39-1 (Turfgrass)*,

◆ 100 percent overlap

- Walking backwards to avoid travel in the treated area, make your first swath.
- To achieve 100 percent overlap, the middle of your next swath should be centered on the edge of your last swath. In other words, with each new swath, you will cover 50 percent previously treated and 50 percent previously untreated ground.
- Finish up by treating the header strips (area at the ends of the swaths).

Note: This method essentially delivers two applications, each at one-half the total application rate.



Figure 5. Drop (gravity) spreader.



Figure 6. Rotary centrifugal spreader.

TABLE 7. Granular Applicators

Feature	Shaker spreader	Drop spreader	Rotary spreader
Cost	sold with product	\$40 and up	\$40 and up
Suitability	spot applications	medium jobs	medium to large jobs
Operation	handheld	push-type ground unit	handheld crank unit or push-type ground unit
Notes	Easy to over- or underapply	Very uniform application within the swath, but any steering error causes missed or doubled strips. Avoids unwanted application to sidewalk and driveways. Ground clearance in wet turf may be a problem.	Is not designed to apply a constant amount of material across the entire width of application, so requires specific overlap. Wind may disrupt the pattern. Wider swath width gets the job done faster than drop spreader. Useful for seeding as well.

Cleaning a tank sprayer

1. Spray out as much of the pesticide as reasonable, then fill it about $\frac{1}{4}$ full with clean water, cap and shake the tank, and spray over a legal site. The next step depends on what type of pesticide you used.
- 2A. Typical procedure:
Fill the tank about $\frac{1}{4}$ full with clean water and add enough household detergent (liquid or dry) to make a sudsy solution. Cap the tank and lightly shake and invert the sprayer for about 10 seconds. Spray out over a legal site. Repeat this procedure with clean water (no detergent) until the soap suds disappear. Remember to clean the outside of the sprayer.
- 2B. Did you use a herbicide?
Most herbicides used in the landscape belong to the growth-regulator family (includes 2,4-D and dicamba). If there is a chance you may use the same sprayer for a different purpose (for example, to spray roses), you need to clean the tank even better. Follow both procedures above, then fill the tank with water and add household ammonia (1.5 fl oz per gallon). Cap the sprayer then lightly shake and invert the sprayer to allow mixing. Pump a little through the hose and nozzle, then let it sit for at least two hours, preferably overnight. Spray out over a legal site (ammonia is a source of nitrogen, so a weak, even application to the lawn is not harmful). Flush the system with clean water more than once.

which is available through your local Extension office or the University of Illinois, ITCS Marketing and Distribution, 1917 S. Wright St., Champaign, IL 61820, or (800)345-6087.

Example 3

An insecticide label instructs you to apply 4 pounds of granular product per 1,000 square feet of turf to control grubs.

How can you be sure that your spreader applies this rate? First, look at the product label and the operator's manual for setting and swath-width instructions for the product and spreader you have. Use these instructions only as initial guides for calibration. Is the suggested setting based on a single (full-rate) application or a 100 percent overlap (half-swath) application method? (See the sidebar for a description of 100 percent-overlap.) Second, refer to the area calculations in the sidebars on the previous pages as a refresher on how to measure land areas accurately. Finally, use this information and the following method to calibrate your spreader accurately.

In a nutshell, the easiest method for checking the delivery rate of a spreader is to apply a pre-weighed amount of product over a measured area (at least 1,000 square feet), and then determine the rate actually delivered. Unlike calibrating a sprayer, you need to use the real product during the calibration run. If you don't trust the suggested spreader setting instructions, be on the safe side and use a lower setting. You can always apply more later, but you can't correct an overapplication. Based on the calibration run, adjust the setting and, if needed, repeat the calibration process on another untreated area.

Cleanup and storage. When you are finished, pour any remaining granules back into the original, labeled container and tightly reseal to prevent wetting and clumping due to humidity. Store all granular products in a dry, safe location out of reach of children. Wash your spreader thoroughly and let it dry out completely in the sun before storing in a dry location.

For Your Protection

Always handle pesticides with respect. After all, the people most likely to suffer ill effects from pesticides are the applicator and his or her family. Accidents and careless, needless overexposure can be avoided. Every year, there are deaths due to accidental ingestion of pesticides.

Each year, more than 750 Illinois children under 12 years of age are rushed to a doctor because of suspected pesticide ingestion or excessive exposure. A study of such cases showed that 50 percent of the children obtained the pesticide while it was in use and 13 percent obtained it from storage. Fifty-three percent of the cases involved pesticides used as baits. These accidents could have been prevented. The following suggestions for safe use of pesticides are designed to prevent such unfortunate, careless accidents.

1. Store pesticides out of reach of children, irresponsible persons, or animals; store in a locked cabinet away from food or feed.
2. Put pesticide containers back in the storage area before applying the pesticide. Children have found open bottles by the water tap.
3. Avoid breathing pesticide sprays and dusts over an extended period. Be especially cautious about this in enclosed areas such as crawl spaces, closets, basements, and attics.
4. Wash with soap and water all exposed parts of the body and clothes contaminated with pesticide.
5. Wear rubber gloves when handling pesticide concentrates.
6. Do not smoke, eat, or drink while handling or using pesticides.
7. Do not blow out clogged nozzles with your mouth.
8. Leave unused pesticides in their original containers with the labels on them and in locked cabinets.
9. Wash out empty pesticide containers three times and then bury them or place them in the garbage.
10. Do not leave puddles of spray on impervious surfaces.
11. Do not apply pesticides to fish ponds, birdbaths, or pet dishes.
12. Do not apply pesticides to dug wells, cisterns, or other water sources.
13. Observe all precautions listed on the label. Use pesticides only on the crops specified, in amounts specified, and at times specified.

Authors

R. Cloyd, P. Nixon, and M. Wiesbrook

Department of Natural Resources and Environmental Sciences

B. Paulsrud

Department of Crop Sciences

M. Mohr

Department of Agricultural Engineering



APPENDIX

PLANT CLINIC SPECIMEN DATA FORM

Plant Clinic
1401 W. St. Mary's Road
Urbana, IL 61802

UNIVERSITY OF ILLINOIS
PLANT CLINIC SPECIMEN DATA FORM

Submitter _____
 Grower _____
 Commercial _____
 Home grower _____
 County _____

Office use only

Plant Clinic # _____
Date received _____
County _____
Charge _____
Date paid _____ Ck # _____

Send response to Name _____
 Address _____
 City _____ State _____ Zip _____
 Phone # _____ E-mail _____
 Crop or plant name _____ Variety _____
 Describe problems or symptom in detail/sketch distribution:

--	--

Symptoms appeared in past: Days_____Weeks_____Months_____

Describe conditions prior to symptom development:

Temperature_____Rainfall_____Other_____

Planting history: Crop two years ago _____ Crop one year ago _____

Soil type _____ pH _____ % organic matter _____

Soil test information

Type of nitrogen application

Chemicals applied this year

Fertilizer_____Type of application _____

Herbicide(s) _____

Rates

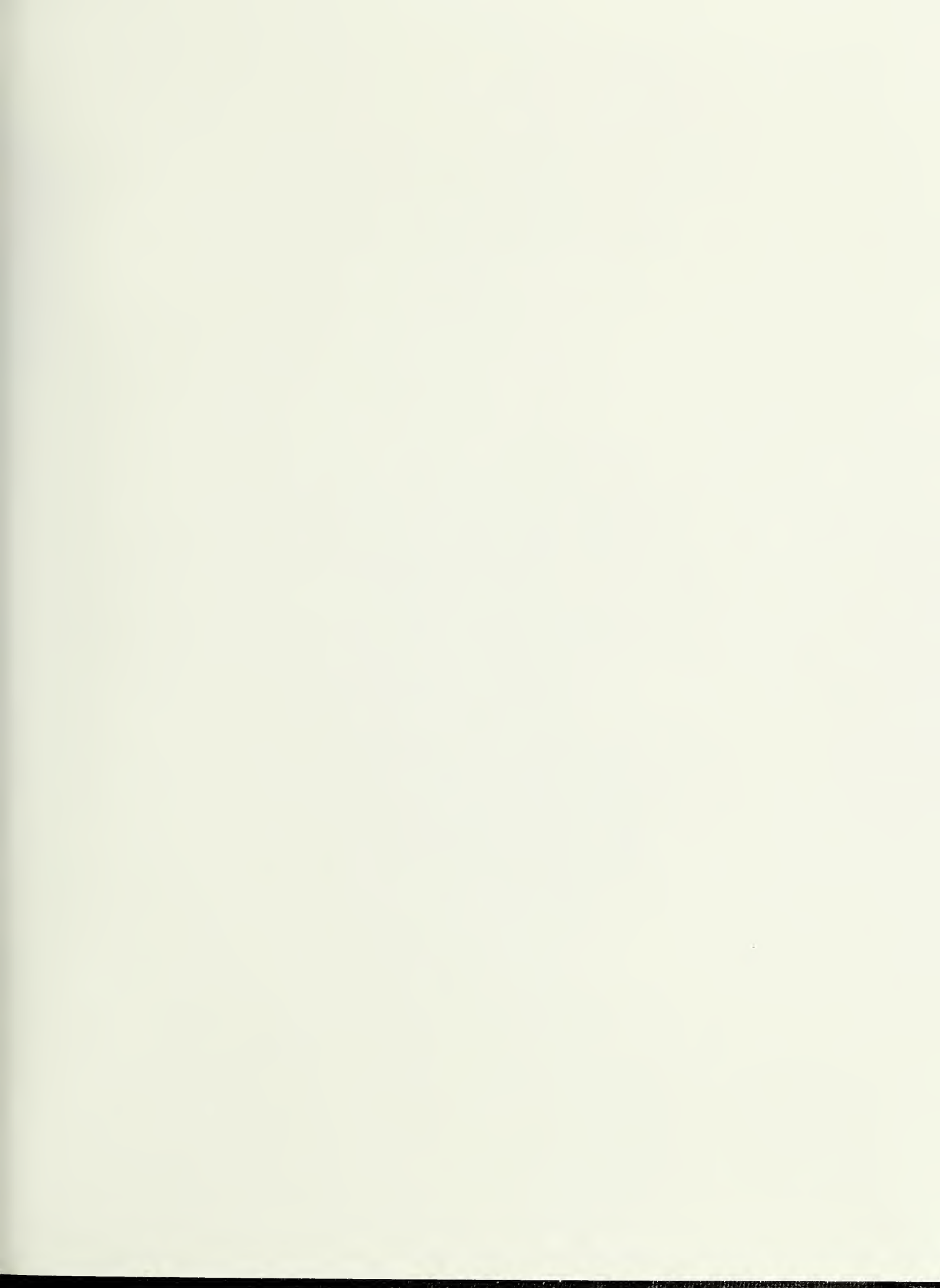
Type of application

Chemicals applied last year _____

Ornamentals

Approximate age and size _____

Condition of nearby species





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We all know that gardening is more than growing flowers, fruits, and vegetables.

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If you're ready to roll up the welcome mat on insect pests, weeds, and diseases, this book is just what you need. The *Home, Yard, & Garden Pest Guide* is designed to help you conquer gardening's worst troublemakers. Inside, you'll find

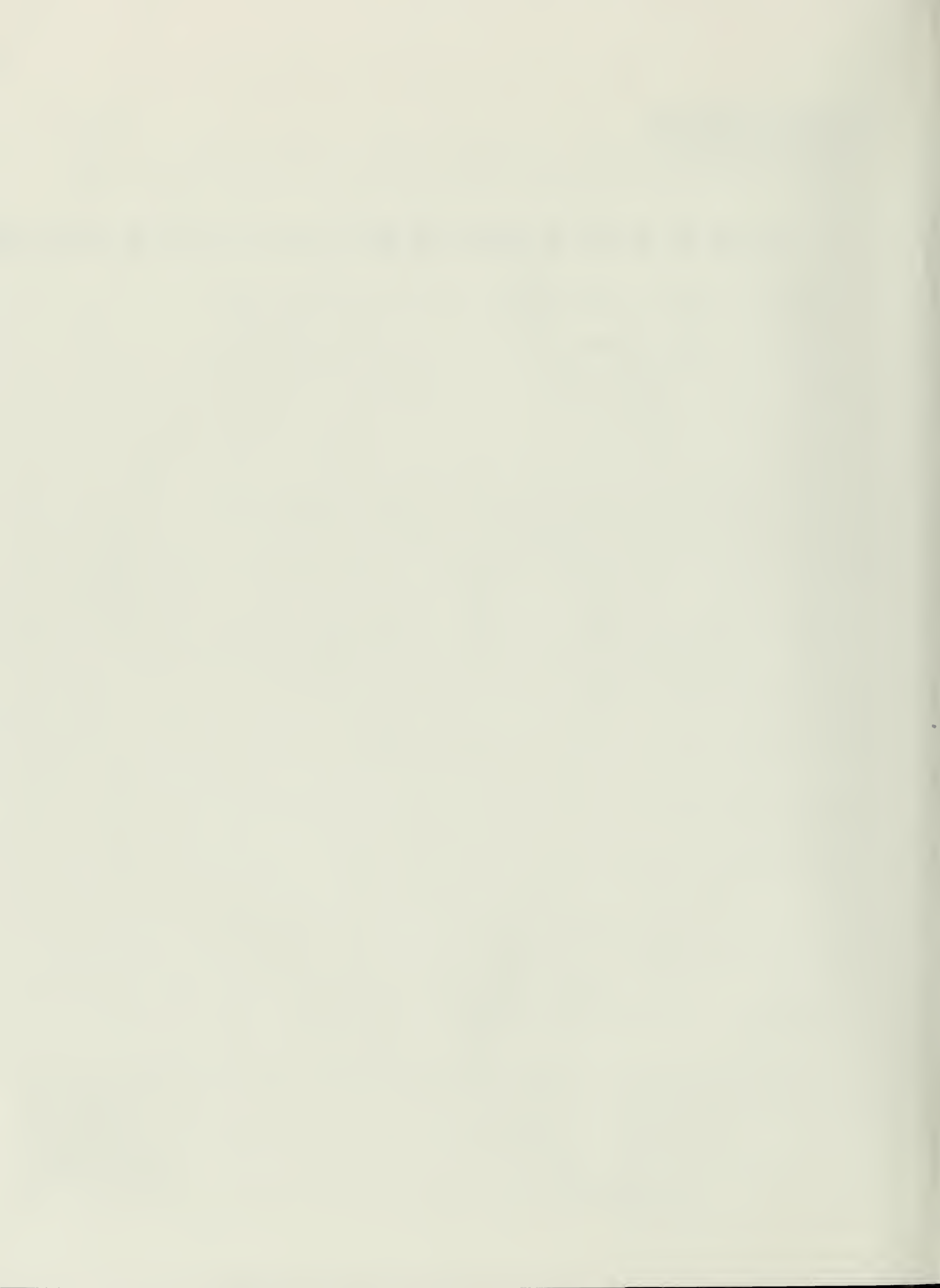
- information grouped conveniently by type of problem: weed, insect, or disease.
- nonchemical alternatives that help you protect your home environment without sacrificing effectiveness.
- charts and tables instead of lengthy prose that offer quick answers to specific chemical application questions and up-to-date herbicide recommendations with efficacy ratings.
- extensively revised listings of fungicides for turfgrass, flower, and woody ornamental diseases.
- fungicide application timing for superior results.
- expanded list of turfgrass weeds for more accurate identification and better management, including application recommendations for broadleaf postemergence herbicides.
- references to author-approved gardening Web sites and other resources.

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